# DEPARTMENT OF THE ARMY
# UNITED STATES ARMY INFORMATION SYSTEMS ENGINEERING COMMAND
# FORT HUACHUCA, ARIZONA 85613-5300

# TECHNICAL GUIDE FOR INSTALLATION INFORMATION INFRASTRUCTURE ARCHITECTURE

**BY**

**FREDERICK M. SKROBAN II**

**MARCH 2006**

**FORT DETRICK ENGINEERING DIRECTORATE**

**Distribution C**

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Technical Guide for Installation Information
Infrastructure Architecture, March 2006

# TECHNICAL GUIDE
# FOR
# INSTALLATION INFORMATION
# INFRASTRUCTURE ARCHITECTURE

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# TECHNICAL GUIDE FOR INSTALLATION INFORMATION INFRASTRUCTURE ARCHITECTURE

## 1.0 INTRODUCTION.

This Technical Guide (TG) provides guidance for the planning, design, and implementation of the Installation Information Infrastructure Architecture (I3A) for Army installations worldwide. This document will establish an implementation concept that can be used to shape architectural templates and influence the design process for the I3A. It will identify proven infrastructure construction techniques, define common practices, and serve as an authoritative implementation guide.

### 1.1 Background.

In previous engineering designs each area of communications was addressed separately, to include design standards, schedules, and funding. This approach led to confusion, design re-engineering, and duplication of effort. The I3A concept was initiated to synchronize the efforts and formulate a more efficient and effective design process. The I3A establishes an Army-wide Information Technology (IT) architectural design standard. The I3A is the source to fuel effective Army Knowledge Management (AKM) necessary to support the Army Transformation Campaign Plan. The I3A captures installation infrastructure, synchronizes the implementation of automation programs, provides for analysis of operational force and sustaining base connectivity, and identifies costs associated with IT modernization. The I3A Configuration Control Board (CCB) manages I3A issues and tracks developments in IT, information assurance , enterprise systems management (ESM), and automation information system (AIS). The Configuration Control Board (CCB), which oversees several working groups that address IT issues, meets quarterly.

### 1.2 Scope.

This document is intended to support gathering the necessary requirements, conducting site surveys, and performing analysis, design and implementation of IT. This guide specifically assists the designer in the integration of the telecommunications and information systems. This guide is synchronized with the Unified Facilities Criteria (UFC), which are mandated under Department of Defense (DOD) policy. The UFC) system is prescribed by Military Standard (MIL-STD) 3007 and provides planning, design, construction, sustainment, restoration, and modernization criteria, and applies to the military departments, the defense agencies, and the DOD field activities in accordance with (IAW) Under Secretary of Defense for Acquisition Technology and Logistics (AT&L) memorandum, 29 May 2002.

The UFC are living documents and will be periodically reviewed, updated, and made available to users as part of the Services' responsibility for providing technical criteria for military construction. Headquarters, U.S. Army Corps of Engineers (USACOE), Naval Facilities Engineering Command (NAVFAC), and Air Force Civil Engineer Support Agency (AFCESA) are responsible for administration of the UFC system. Defense agencies should contact the preparing service for document interpretation and improvements. Technical content of UFC is the responsibility of the cognizant DOD working group. Recommended changes with supporting rationale should be sent to the respective service proponent office by Criteria Change Request (CCR). The UFC are effective upon issuance and are distributed only in electronic media from the following sources: *Whole Building Design Guide* World Wide Web (Web)-site http://dod.wbdg.org/. Hard copies of UFC printed from electronic media should be checked against the current electronic version prior to use to ensure that they are current.

### 1.3 Supporting Appendices or Attachments.

This TG is divided into six sections: Introduction, System Overview, Evaluation Process, Site Survey Results, Risks, and Conclusions and Recommendations. There are four appendices and a Glossary of acronyms and abbreviations is provided.

- Appendix A – Technical Guidance Checklist for I3A
- Appendix B – Building Cabling System (BCS) Figures
- Appendix C – North America and Europe Drawings
- Appendix D - References

## 2.0 BUILDING TELECOMMUNICATIONS CABLING SYSTEM SPECIFICATIONS.

The BBCS is designed to satisfy I3A policy information system (IS) requirements within a facility. The BCS must be installed IAW the Telecommunications Industry Association (TIA) and Electronics Industry Association (EIA) Building Telecommunications Wiring Standards general guidelines with modifications and clarifications provided below. The TIA/EIA specifications can be purchased at http://www.tiaonline.org/standards/. Telecommunications design should be performed and stamped by a Registered Communications Distribution Designer (RCDD). This BCS section is synchronized with UFC 3-580-1, Telecommunications Building Cabling Systems Planning and Design. The objective of this UFC is to provide planning guidance for the development of an input to the BCS telecommunications portion of the DD 1391. The UFC-3-580-1 is designed to satisfy I3A policy or UFC 3-580-10 Design: Navy and Marine Corps Intranet (NMCI) Standard Construction Practices IS requirements within a facility.

### 2.1 Classified Information Infrastructure.

Engineers engaged in the design of classified (collateral or higher) information infrastructure must coordinate the infrastructure design with the Certified Telecommunications Electronics Material Protected from Emanating Spurious Transmissions (TEMPEST) Technical Authority (CTTA) and Designated Accreditation Authority (DAA) responsible for that area. The designer should also refer to the U.S. Army Information Systems Engineering Command (USAISEC) TG for the Integration of SECRET Internet Protocol (IP) Router Network (SIPRNET) (January 2006). The USAISEC SIPRNET document is an IT systems security engineering guide for communicators supporting the war fighter. The TG may be used to assist Army personnel in developing access solutions for SIPRNET connectivity to support the war fighter’s increased use of secure networking and methods of interfacing with secure IT in CONUS. Although the document may contain some information that may be useful in the OCONUS environment, the exact specifications and requirements in that theater may differ from the CONUS theater. The USAISEC SIPRNET guide is based upon applicable National Security Agency (NSA), DOD, Defense Information Systems Agency (DISA), and Department of the Army (DA) documents.

## 2.2 Building Telecommunications Cabling System Overview.

An acceptable BCS encompasses: copper and fiber optic (FO) entrance cable, termination equipment, copper and fiber backbone cable, copper and fiber horizontal distribution cable, workstation outlets, racks, cable management, patch panels, cable tray, cable ladder, grounding, and labeling. Figure B-1 of Appendix B provides an overview of the cable entrance and backbone distribution. Figure B-2 of Appendix B provides and overview of the horizontal distribution.

## 2.3 Workstation Outlet.

The following specifications pertain to telecommunications outlets and connectors:

### 2.3.1 Outlet Box.

Specify double gang electrical boxes of at least 2-1/8 inches (in) (54 millimeters (mm)) depth to provide dedicated space for current and possible future FO cable (FOC) installation. For single connector outlets, such as voice-only, cable television (community antenna television (CATV)) or closed circuit television (CCTV), use a single gang 2 in by 4 in by 2-1/4 in (51 mm x 102 mm x 57 mm), electrical box recess mounted, with the faceplate flush with the wall surface. Locate a service power outlet within 6 inches (152 millimeters (mm)) of the CATV or CCTV outlet. Designers should specify 4-11/16-in (119 mm) square by 2-1/4 (57 mm) boxes for 1-in (27 mm) conduit installations and outlet boxes that have or may require FO cabling.

### 2.3.2 Outlet Faceplate.

Use a full (double gang) faceplate for standard administrative outlet locations, with connectors for all copper and, if used, FOC. Standard administrative outlets may, by specific user request, use single gang outlet faceplates in conjunction with a reducing ring. For single gang outlet boxes, use a single gang outlet faceplate with appropriate connector locations and, if required, mounting lugs for wall telephones. Outlet faceplate must include two blank positions for future applications.

### 2.3.3 Outlet Connectors.

The following specifications pertain to copper, FO and coaxial cable outlet/connector. The category for cable, jacks, termination blocks, and patch panels must be the same throughout each circuit and system. Specify more than one category only if providing more than one system requiring different categories. In general for horizontal cable, Category 6 (Cat 6) must be used for all voice and data circuits.

#### 2.3.3.1 Copper Outlet/Connector.

Copper outlet/connector must be TIA/EIA Ct 6 for all projects. All connectors must be 8-pin/8-position insulation displacement terminations wired per T568A (default configuration) or T568B (if required to maintain system configuration uniformity, security or other user-specified reasons). Category 5 (Cat 5), Category 5e (Cat 5e), and Category 3 (Cat 3) rated connectors must not be used in new construction or rehabilitation projects. Copper outlet/connector and plugs should be un-keyed unless the user requires keyed outlet/connector and plugs to maintain system uniformity, security, or other user specified reasons.

#### 2.3.3.2 FO Outlet/Connector.

Terminate all FO work area cables in dual 568SC connectors. Provide FO connectors IAW the paragraph entitled FO Terminations in this TG. The default choice for FO outlet/connector must be TIA/EIA "SC" type (568SC). Other type connectors (small-form-factor) (MT-RJ, VF-45, etc.) may be substituted as required by the user. Small form factor connectors (available from several manufacturers), offer a potential for significant installation cost reduction. Any type of fiber connector used must meet the performance requirements specified within Annex A of TIA/EIA-568-B.3, and meet the requirements of the corresponding TIA FO Connector Intermateability Standard (FOCIS) document.

#### 2.3.3.3 Coaxial Outlet/Connector.

Coaxial outlet/connector should normally be "F" type connectors. Use of other type connectors (i.e., Bayonet Neill Concelman (BNC), etc.) should be considered only if specifically required by the user. The designer must coordinate with the cable service provider where franchise agreements are in place. All passive CATV devices should support 1 Gigahertz (GHz) bandwidth.

### 2.3.4 Outlet/Connector Markings.

Each communications outlet must have a unique identifying number IAW TIA/EIA 606-A. In the telecommunications room (TR), this unique identifying number must be associated with the position on the patch panel or cross-connect to which the outlet is connected. Each horizontal cable must be labeled both at the outlet and patch panel or cross-connect position in the communications closet. Connector voice and data dedication use may be reassigned as requirements dictate. **Note:** In the standard cabling scheme, the designations "voice" and "data" are arbitrary and do not imply that one outlet is better than the other, the outlets are identical in capability.

### 2.3.5 Outlet Types and Density.

Table 1 shows outlet types that are commonly used in military construction projects. Sketches of these outlets are included in Figure B-7 of Appendix B. The outlet types do not cover all possible user required configurations. The designer must certify that all user-defined outlets have a corresponding valid requirement, such as fiber for various levels of classification. Outlet configurations must comply with this TG, TIA/EIA-568-B, and TIA/EIA-569-B. Outlet densities are provided for planning purposes, when actual outlet locations are not known and cannot be determined with available information. The designer can develop reasonably accurate total outlet count estimates based on the size and dedicated usage of the space. These factors fall within the ranges given in TIA/EIA-569-B, and are based on gross area (overall building footprint without deducting for hallways, equipment rooms, restrooms, etc.). See Figure B-9 of Appendix B for a typical building floor plan.

**Table 1. Outlet Types**

| Facility Space Category | Outlet Configuration | Planning Area (SF(SM)) per Outlet |
|---|---|---|
| Administrative space, to include classrooms, and medical/clinics | Two 8-pin modular (RJ45 type) outlet/connector in a double gang outlet faceplate, one connector labeled voice use and one labeled data use. | 80(7.5) |
| Headquarters and special users | Minimum of two 8-pin modular (RJ45 type) outlet/connector in a double gang outlet faceplate, one connector labeled voice use and one labeled data use, with additional 8-pin modular and/or fiber outlet/connectors as required. | 80(7.5) |
| Systems furniture | Two 8-pin modular (RJ45 type) outlet/connector in a modular furniture outlet faceplate with outlet box extender, one connector labeled voice use, and one connector labeled data use. | See below |
| Non-admin spaces (CDCs, chapels, Recreation centers, etc.) | Two 8-pin modular (RJ45 type) outlet/connector in a double gang outlet faceplate, one connector labeled voice use and one labeled data use. | 500(46.5) |
| Barracks space/bachelor officer's quarters (BOQ) | See below | See below |

| Facility Space Category | Outlet Configuration | Planning Area (SF(SM)) per Outlet |
|---|---|---|
| Warehouse space | Two 8-pin modular (RJ45 type) outlet/connector in a double gang outlet faceplate, one connector labeled voice use and one labeled data use. | 5000(465) |
| Wall and pay telephone outlet | One 8-pin modular (RJ45 type) connector in a single gang outlet faceplate with mounting lugs, labeled voice use. | As needed |
| Family housing units | See below | See below |
| Wireless access points | One 8-pin modular (RJ45 type) connectors in a single gang outlet box labeled for data. | See below |

#### 2.3.5.1 Family Housing Units.

The designer must determine the minimum outlet quantity for Army Family Housing (AFH) units based upon the number of rooms in the AFH unit. In general, provide one telephone outlet and one CATV outlet (as a minimum) in each of the following: kitchen, living room, dining room, family room/area, each bedroom, and any other logical location deemed appropriate. Copper outlet/connector must be TIA/EIA Cat 6 for U.S. Army and U.S. Air Force projects.

#### 2.3.5.2 BOQ.

For U.S. Army barracks projects, provide one 8-pin modular (RJ45 type) connector in a single gang outlet faceplate, labeled voice use. In Bachelor Enlisted Quarters

(BEQ), BOQ, Senior Enlisted Bachelor Quarters (SEBQ)/etc., provide one single RJ-45 outlet in each room of the suite; i.e., bedroom and living room, configured per TIA/EIA-570.

#### 2.3.5.3 Systems Furniture Wiring.

The designer must specify a minimum of one systems furniture outlet per single occupancy cubicle. The designer must specify a minimum of two systems furniture outlets per cubicle designated for servers, printers, copiers, or facsimile (FAX) machines. When systems furniture is installed as part of the construction contract, ensure that systems furniture specifications include EIA American National Standards Institute (ANSI)/TIA/EIA-568-B and EIA ANSI/TIA/EIA-569-B cabling and raceway standards.

#### 2.3.5.4 Wireless Access Point (WAP) Cabling.

Wireless access points may be required in some situations. If the project management for IT has approved the inclusion of wireless in the design, the recommendations here should be followed. The designer should specify one-Cat 6, unshielded twisted pair (UTP) cable, each to a standard 8-pin modular connector for each wireless AP outlet. The Cat 6 cable can be used in conjunction with Power over Ethernet (PoE) to provide both power and data to the AP. The TIA/EIA technical committee TR-42 is currently working on a Technical Service Bulletin (TSB-162) *Telecommunications Cabling Guidelines for Wireless Access Points*. The intent of this TSB is to provide a pre-cabled grid to support 802.11 wireless local area networks (LAN). The current guidance is to place one WAP at the center of each 55 by 55 foot (ft) square grid, for up to 20 users. For grid locations with over 20 users, provide two UTP cables. The TSB is based upon International Standards Organization (ISO)/International Engineering Consortium (IEC) TR 24704 Information Technology Cu*stomer Premises Cabling for Wireless Access Points*. Both TIA and ISO utilize a 39-ft (12 meters (m)) diameter circle for WAP coverage. The designer should note that a wireless survey will be required after the completion of construction to ensure proper wireless coverage. The WAP grid provides a foundation for implementing wireless, but does not eliminate final wireless design.

#### 2.3.5.5 General Range Information Infrastructure Design.

The telecommunications sections of range construction projects should follow the general provisions of this I3A TG for new construction and renovations. There are several distinct types of information networks in a range environment: administrative, range control and tactical. The administrative networks support telephone and data requirements to the occupants of the range buildings, and safety telephones. The special Range Control networks control downrange targets, sensors, and monitors and transport this information to off-site locations. The tactical networks support the unit training requirements in a field environment. In addition, there could be security and alarm networks.

### 2.3.6 Utility Rooms and Closets.

All utility rooms and closets, such as electrical, mechanical and telecommunications, must be wired with at least one wall mounted telecommunications outlet, with a mounting lug face plate.

### 2.3.7 Elevators.

For buildings with elevators, a four-pair copper cable with an eight-position modular outlet adapter must be installed for each elevator. The exact location of the outlet assembly must be verified with the elevator installer or contractor.

### 2.3.8 Safety, Courtesy, and Convenience.

Provide wall outlets at all logical locations to support safety, courtesy, and convenience. Examples include safety: barracks hall, laundry room; courtesy: building lobby/entrance, stairways; convenience: break rooms, rear (unmanned) entrances.

### 2.3.9 Building Automation Systems (BAS).

When requested by the building support systems planner, provide wall outlets at identified locations to support BAS. For example, one such outlet may be a direct digital controller (DDC) outlet for the heating, ventilation, cooling (HVAC) system. The IS/IT-designer does not have primary responsibility for identifying these circuits, and should defer to the building support systems planner. Applying a BAS requires close coordination between the IT designer and the various utilities and automated systems designers. The TIA/EIA published *TIA/EIA-862 Building Automation Systems Cabling Standard for Commercial Buildings* in April of 2002, to specify a generic cabling system for BAS. The TIA/EIA-862 defines the TR and equipment rooms, BAS outlets, connection points, cross-connects, device terminations, and interconnection point details for the building utilities. The TIA/EIA-862 uses the same cabling technology and architecture as TIA/EIA-568-B, and Section 6 of TIA/EIA-862 provides coverage area planning for typical BAS links. The TIA/EIA-862 states that BAS controllers should be located and cabling should be terminated in the TRs serving that area. Additionally, Section 7.3 states "Because the scope of ANSI/TIA/EIA-569-A does not cover BAS cabling, additional pathway and space capacity may be required." Actual building systems equipment should be located in the respective mechanical rooms and should be distinct from the TR.

### 2.4 Building Telecommunications Wiring.

The following information pertains to horizontal cable and backbone cable. All horizontal and backbone wiring must be designed in a star-configuration as defined in TIA/EIA-568-B.1. All cables must be terminated within TRs, telecommunications equipment rooms, and work areas.

#### 2.4.1 Horizontal Cable.

The following information pertains to copper, FOC, and cable run lengths.

##### 2.4.1.1 Copper Voice and Data.

One Cat 6, for general projects, UTP cable must be installed to each standard 8-pin modular connector provisioned at the outlet. For example, install two 4-pair UTP cables to a standard administrative outlet, or one 4-pair UTP cable to each single connector outlet. Copper cables must not be split between multiple modular connectors. Use only cable that has passed the Underwriters Laboratory (UL) LAN certification program and is labeled with UL acceptable markings. Plenum cables must be provided IAW National Fire Protection Association, Inc. (NFPA) 70, or when directed by the facility safety officer or local building code. Provide terminations IAW the paragraph entitled "Copper Termination" in this TG. The designer must not use 150 ohm shielded twisted pair for new construction. The Cat 5, Cat 5e, and Cat 3 rated cable must not be used in new construction or rehabilitation projects.

a. Copper Termination.

Terminations must be performed using an 8-pin (RJ45 type) connector, rated for the category of the installed cable. In a standard cabling scheme, horizontal cables are arbitrarily designated "voice" and "data" to identify and differentiate their purpose. Copper distribution cable must be terminated at the TR on 110-type cabinet or rack-mounted patch panels compliant with Cat 6 for general projects. Very small projects (i.e., one or two telephones) may use an EIA/TIA category qualified block or backboard mounted patch panel. Cables from the same outlet must be terminated on the same patch panel and individually identified. All terminations must be wired to the TIA/EIA T568A configuration. Do not use T568B wiring configurations unless specifically requested by the user and approved by the authority having jurisdiction. Copper cables must not be split between multiple modular connectors.

b. Copper Patch Cables.

Copper patch cables must be 4-pair, 24 American Wire Gauge (AWG) stranded UTP cable, rated for Cat 6, with 8-pin modular connectors at each end. Provide sufficient copper patch cables, of various appropriate lengths, to terminate all copper patch panel appearances.

c. Category 6 Augmented and Category 7.

The TIA/EIA is the United States trade organization and standards body that specifies structured cabling systems. The ISO/IEC is a network of the national standards institutes of 151 countries and international standards body responsible for specifying structured cabling systems. The TIA committee TR-42 has a task group working on standards for 10GBase-T cabling, or augmented Cat 6, as does ISO/IEC. Neither group is scheduled to have a standard ratified before mid-2006. The ISO/IEC currently has a standard for a shielded-twisted pair (STP) cabling system, designated as Class F. The TIA/EIA has not yet formed a task group to explore the standardization of ISO/IEC 11801 Class F as Category 7. As of the publication of this TG, implementation of an augmented Cat 6 runs the risk of being non-standards compliant, and obsolete upon ratification of the standard. Implementation of Class F cabling within the United States also runs the risk of utilizing a non-standard termination connector.

#### 2.4.1.2 FOC.

Provide FOC to each outlet only at the specific request of the user, or the DAA. As a minimum, administrative (including hospital) outlet boxes and faceplates must be sized and configured to allow for the future installation of two strands of FOC. When the user requires FOC, multi-mode 50/125-micron cable or 62.5/125-micron should be installed. Single-mode FOC may be substituted as required by the user. Plenum cables must be provided IAW NFPA 70, or when directed by facility safety officer or local building code.

a. FO Termination.

All FO distribution cable must be terminated in cabinet/rack-mounted patch panels, and at the outlet. Do not use smart terminal (ST) style adapters for new construction unless specifically required for interface with existing equipment reused on installations. Check with activity for specific requirements for ST adapters. The default choice for FO adapters and connectors must be TIA/EIA "subscriber connector (SC)" type (568SC). TIA/EIA 604-3A "SC" type connectors are preferred in new systems as the international standard now accepted by the U.S. Government. Other type connectors (small-form-factor) (MT-RJ, VF-45, etc.) may be substituted as required by the user. Provide FO adapters and connectors IAW TIA/EIA-604 FOCIS and the corresponding FOCIS for the type of connector used.

b. FO Patch Cables.

Fiber optic patch cables must be using the same FOC type and connectors as the patch panels they are interconnecting. Duplex patch cables must be used. Provide sufficient FO patch cables, of various appropriate lengths, to terminate all FO patch panel (FOPP) appearances plus 25 percent spare.

#### 2.4.1.3 Cable Length.

Copper data cable length must be limited to 295 ft (90 m) from patch panel termination in the TR to the data outlet termination IAW TIA/EIA-568-B.1. Adjust the average cable length for planning purposes as required (i.e., average measured length). Exception: buildings with collapsed backbones that use FOCs for all data and copper UTP for voice-only, may exceed the 295 ft length.

### 2.4.2 Backbone Cable.

The following subparagraphs pertain to copper and FO backbone cable. The building backbone must have no more than two hierarchical levels of cross-connects. Copper backbone cable must be used only for voice circuits. Data backbone circuits must be FOs.

#### 2.4.2.1 Copper Backbone Cable.

Multi-pair voice backbone cable must meet the requirements of Insulated Cable Engineers Association (ICEA) S-80-576 and TIA/EIA-568-B.2 for riser rated UTP cable. Conductors must be solid un-tinned copper, 24 AWG. The copper backbone cable originating in the main TR or main cross connect must be terminated in each TR on 110 type, insulation displacement, wiring blocks mounted on the telephone backboard. Provide at least two backbone cable pairs for every outlet connected to the TR served by the backbone cable. Plenum cables must be provided IAWNFPA 70, or when directed by the facility safety officer. The ICEA specifications are listed in the references, and can be purchased at http://global.ihs.com.

#### 2.4.2.2 Copper Termination.

Termination must be performed using 110-type connectors, rated for the installed cable. All terminations must be wired IAW TIA/EIA T568A. In a standard cabling scheme, horizontal cables are arbitrarily designated "voice" and "data" to identify and differentiate their purpose. Twisted pair outside plant (OSP) cable is terminated on the Protected Entrance Terminal (PET). See Figures B-5 and B-6 of Appendix B for details. Cross-connects can then be placed from the PET to the first set of 110-type terminal blocks as needed. The first set of terminal blocks provides connection for all backbones and for outlets served by the main TR. For main TRs that contain a telephone distribution frame, the horizontal main distribution frame (MDF) blocks must serve as the main cross connects. Refer to MDF description in the section on Dial Central Offices (DCO) in the *USAISEC TG for Circuit Switching*. For example, in a three-floor building, one backbone cable must be terminated on 110-type blocks on the same backboard as the PET; one backbone cable should be terminated on 110-type blocks in the second floor TR; and one backbone cable should be terminated on 110-type blocks in the third floor TR. A backbone cable connects a second set of 110-type blocks in each TR to a rack mounted, 8-pin (RJ45 type) connector voice patch panel. This panel can be patched to the distribution patch panel, which in turn terminates the Cat 6 outlet wiring. Cross-connects can be done by the Director of Information Management (DOIM)/telephone personnel, and jumpers can be installed by the user/Information Mission Area (IMA) department, providing the desired connectivity between the OSP and the inside plant wiring. This design allows maximum flexibility for future moves, additions, and changes.

#### 2.4.2.3 FO Backbone Cable.

For all projects, a minimum of 12 strands of 50/125-micron or 62.5/125-micron multimode FOC and 12 strands single mode FOC must be installed between the main TR or main cross connect and each TR. If requested by the user, only 12 strands of one type of fiber may be used. Plenum cables must be provided IAW NFPA 70, or when directed by local regulations.

**Note:** The U.S. Army Gigabit Ethernet (GbE) data network architecture dictates the use of single mode FOC between TRs.

FO Termination. All FO backbone cable must be terminated in cabinet/rack-mounted patch panels, at each end. Do not use ST style adapters for new construction unless specifically required for interface with existing equipment reused on installations. Check with activity for specific requirements for ST adapters. The default choice for FO adapters and connectors must be TIA/EIA “SC” type (568SC). TIA/EIA 604-3A “SC” type connectors are preferred in new systems as the international standard now accepted by the U.S. Government. Other type connectors (small-form-factor) (MT-RJ, VF-45, etc.) may be substituted as required by the user. Provide FO adapters and connectors IAW TIA/EIA-604 FOCIS and the corresponding FOCIS for the type of connector used.

### 2.4.3 CATV or CCTV Cable.

When CATV or CCTV requirements are identified, either a 75-ohm broadband coaxial cable or single-mode FOC system should be installed. Refer to the paragraphs above for FOC. When a coaxial system is installed, care must be taken to ensure the correct cable is used. The designer must coordinate with the cable service provider where franchised agreements are in place. Plenum cables must be provided IAW NFPA 70 or when directed by the facility safety officer. The table below lists cable types with corresponding distance limitation. Table 2 is derived from vendor specifications (Anixter) for coaxial cable. The RG-59 must not be used for CATV projects; however, RG-6 should be used to outlet locations and RG-11 for feeder and trunk cables.

**Table 2. Coaxial Cable**

| Cable | Distance (feet) | Distance (meters) |
|---|---|---|
| RG-6 | <=250 | <=76 |
| RG-11 | <=400 | <=122 |
| 625 Series | >400 | >122 |

#### 2.4.3.1 CATV Systems.

Community antenna TV systems are generally referred to as cable TV. The CATV systems must be designed IAW (1) where required, provide a complete system to be owned and maintained by the U.S. Government including backbone consisting of backboards/cabinets and wire and conduit with outlets and jacks in all offices, and (2) other locations as required by the user. System must be designed IAW applicable TIA/EIA, Building Industry Consulting Service International (BICSI), and NFPA 70 standards, and must be coordinated with the local CATV service provider. System must include head end amplifier when required by the local provider, amplifiers, splitters, combiners, line taps, cables, outlets, tilt compensators, and all other parts, components, and equipment necessary to provide a complete and usable system. System must provide a high quality signal to all outlets with a return path for interactive television and cable modem access. The system must be designed to operate within the 5 to 1000 Megahertz (MHz) bandwidth using 1000 MHz passive devices and a minimum of 750 MHz active devices. Each outlet must have a minimum signal level of 0 decibel millivolts (dBmV) (1000 microvolts) and a maximum of 15 dBmV at 55 and 750 MHz.

Distribution system must be star topology with each outlet connected to a communications closet with a feeder cable or a drop cable and each communications closet connected to the head end equipment with a trunk cable.

Provide cable installed in conduit as follows:

- Trunk Cable, RG-11 or 625 series
- Feeder cable, RG-11
- Drop Cable, RG-6

### 2.4.4 Building Infrastructure.

See Figures B-1 through B-8 of Appendix B for details. Figure B-9 of Appendix B provides a typical floor plan used in designing a building or office cabling system.

#### 2.4.4.1 Cable Tray.

Solid bottom, slotted bottom, or welded wire cable tray should be used to provide a centralized cable management/distribution system. See Figure B-5 of Appendix B for details. Provide 1 square inch (650 square mm) cross-sectional area of the tray or wire way for each outlet location served. Cable trays must be designed to accommodate a maximum calculated fill ratio of 50 percent to a maximum inside depth of 6 inches (150 mm). For barracks, the designer should provide 1 square inch (650 square mm) cross-sectional area of the tray or wire way for each barracks unit, and not exceed the 50 percent fill ratio. Ladder cable tray should be avoided for horizontal distribution. Provide 12 inches of clearance above cable trays for future access. Designers must coordinate with other disciplines to ensure clearances can be achieved.

#### 2.4.4.2 Enclosed Duct (Raceway).

When a building design does not provide for installation of cable tray, enclosed square duct may be installed. Enclosed duct may also be used in place of cable tray when cable plant requires physical security. For initial design guidance, provide 650 square mm (1 square inch) of cross-sectional area of the enclosed duct per outlet location. During actual design, the designer must plan for an optimal fill ratio of 40 percent. Under no circumstances must a fill ratio of 50 percent be exceeded. Provide 12 inches (300 mm) of clearance above cable trays for future access, per TIA/EIA-569-B, paragraph 4.5.6.2.

#### 2.4.4.3 Conduit.

Electrical metallic tubing (EMT) conduit must be installed from the cable backbone distribution system, whether cable tray or enclosed duct, to each outlet. Conduit for standard outlets must be a minimum of 1 inch (27 mm) EMT conduit. When cable tray or enclosed duct is not used, individual conduits should be installed from the TR to each outlet. Conduit bend radii must be coordinated with cable bend radius. Conduit entries at outlet and junction boxes must be arranged so that cables passing through the box must enter and exit at opposite sides of the box. Do not use metal flex conduit for telecommunications wiring except when installing floor-access boxes in a raised floor, where floor-access box must be relocated within a specified service area: i.e., 15-20 ft radius typical. An optimal conduit fill ratio of 40 percent should be accommodated for conduit. Under no circumstances should the designer exceed a fill ratio of 50 percent. No more than four, four-pair cables may be in a 1 inch (27 mm) conduit. **Note:** Conduit must not be used in family housing projects unless it is a high-rise apartment building.

#### 2.4.4.4 Pull Boxes.

Pull boxes must be placed in conduit runs where a continuous conduit length exceeds 100 feet, or where there are more than two 90-degree bends. Pull boxes must be placed in straight runs of conduit and not be used in lieu of a bend.

#### 2.4.4.5 Open Office Wiring.

a. Systems Furniture Wiring

Design systems furniture wiring connections IAW TIA/EIA-569-B.

b. Multi-user Telecommunication Outlet Assembly (MUTOA).

The ANSI/TIA/EIA-568-B.1 allows MUTOAs in an open office environment. This option provides greater flexibility in an office that is frequently reconfigured. A multi-user telecommunications outlet assembly facilitates the termination of single or multiple horizontal cables in a common location within a furniture cluster or similar open area. The cables from MUTOAs to work stations in system furniture or open office are simply long work area cables supported by the systems furniture raceway. The MUTOAs do not include an additional connection, and are limited to terminating a maximum of 12 users. Follow the guidance of ANSI/TIA/EIA-568-B.1, Section 6.4.1 for MUTOA application and design.

c. Consolidation Point (CP).

The CP is an interconnection point within the horizontal cabling using ANSI/TIA/EIA-568-B.2 or ANSI/TIA/EIA-568-B.3 compliant connecting hardware. It differs from the multi-user telecommunications outlet assembly in that it requires an additional connection for each horizontal cable run. The CPs are limited to terminating a maximum of 12 users. Follow the guidance of ANSI/TIA/EIA-568-B.1, Section 6.4.2 for CP application and design.

d. Direct Connection.

Figure B-8 of Appendix B shows two possible solutions for direct wiring to the systems furniture. This concept is one of a continuous home run from the TR to the furniture outlet. Continuous runs are not the recommended method, and should only be used in open office environments that cannot be readily reconfigured. Testing of the installed cable plant is simplified by providing an end-to-end circuit, without an additional connection point. Follow the guidance of ANSI/TIA/EIA-569-B, Section 6.3.2 for direct connection application and design.

e. Protection and Separation.

The implementers must ensure the cable is protected at all transition points, and that metallic separation is provided between telecommunication and power wiring in the power pole and/or systems furniture track IAW TIA/EIA-569-B 10.3 and Article 800-52 of ANSI/NFPA 70.

#### 2.4.4.6 Optional Customer Premise Items.

In new construction, particularly in large administrative or medical facility buildings, cable distribution systems must use the cable tray (or duct) and conduit systems as described. In new construction involving small, mixed use (non administrative) facilities, or construction projects involving renovation of existing buildings, use of "J" hooks, flexible cable tray, and alternative support systems specifically certified for Cat 6, cable is permissible, though not desirable. Surface mounted non-metallic raceway may be used in renovation projects where access to the walls for installation of conduit and outlet boxes is not possible, or where historical requirements prohibit the alteration of the building structure. See Figure B-9 of Appendix B for details.

#### 2.4.4.7 WAPs.

The WAP cabling infrastructure must be installed in the same manner as other telecommunications outlets within the design. The infrastructure must include the cable tray and conduit to support the Cat 6 cable connected to the WAP. The use of “J” hooks, flexible cable tray, and alternative support systems specifically certified for Cat 6, cable is permissible to support small numbers of WAP in an area from the cable tray. Horizontal cabling to distribution areas must be supported in cable tray.

## 2.5 Telecommunications Room.

See Figures B-4 through B-6 of Appendix B for sample closet layouts. TIA/EIA-568-B.1 has replaced telecommunications closet (TC) with TR. The engineer must use the reference to TR to more accurately describe the space needed for telecommunications equipment. In new construction or renovation, take into account the heat load of all active electronic equipment to be installed in TRs and equipment rooms. The designer must estimate these loads and coordinate HVAC requirements. Active electronics must be placed in a conditioned space. Follow requirements of ANSI/TIA/EIA-569-B when active electronics are to be located in TCs and equipment rooms.

### 2.5.1 Multi-story Buildings.

In multi-story buildings, a minimum of one TR should be located on each floor (small facilities, i.e., air traffic control towers, firing ranges, etc., may use one TR for the entire facility). Collapsed backbone buildings, i.e., major command and control (C2) facilities, may reduce the number of TRs to a minimum in line with the collapsed wiring architecture. The TRs on successive floors should be vertically stacked wherever possible. A minimum of three 4-in (103 mm) rigid steel conduits (RSC) must be installed between stacked closets on successive floors, IAW TIA/EIA-569-B.

### 2.5.2 TR Sizing.

The TRs must be sized IAW TIA/EIA-569-B for all new construction projects with primarily administrative function (small mixed-use facilities should not require full compliance with TIA/EIA-569-B). Generally, the TR should be sized to approximately 1.1 percent of the area it serves. For example, a 10,000 square ft (1,000 square meters) area should be served by a minimum of one 11 ft x 10 ft (3.4 m x 3 m) TR. Facilities with requirements exceeding those of the average administrative building (i.e., C2 facilities, etc.) will require TRs sized to approximately two percent or more of the area served. Large floor areas should be divided into “serving areas” with TRs for each serving area. Each serving area can be no larger than 10,000 square feet (1,000 square m) as stipulated in TIA/EIA-569-B. The TR sizing allowances should be made only in cases of construction projects involving building renovation, and under most circumstances a TR must not be smaller than 11 ft x 7 ft (3 m x 2.2 m). The designer must avoid irregular sized TRs, such as narrow rooms or odd shapes. Provide adequate space in TRs to facilitate tenant owned telecommunications system support equipment requirements in tenant installed freestanding cabinets or racks. Total TR space (as a percentage of the building’s area) must be scale upward, to reflect the increased number of circuits in buildings with more than the standard number of circuits to each workspace. Smaller building TRs are covered in Annex B of TIA/EIA-569-B. The designer must consult with the architectural designer or facilities engineer if the TR is to house Voice over Internet Protocol (VoIP), wireless, PoE, or large numbers of network switches. The architectural designer may have to compensate for the additional rack space required to house the VoIP and PoE equipment, uninterruptible power supply (UPS), and servers supporting VoIP and wireless.

#### 2.5.2.1 Range Considerations.

In multi-story buildings, a minimum of one TR should be located on each floor. Small facilities, i.e., air traffic control towers, firing range towers, etc., may use one TR for the entire facility. TRs on successive floors should be vertically stacked wherever possible. A minimum of three 4-inch rigid conduits should be installed between stacked closets on successive floors, IAW EIA/TIA-569-B.

### 2.5.3 Room Interior Finishes.

Floors, walls, and ceilings must be treated to eliminate dust. Finishes should be light in color to enhance room lighting. Dropped ceilings must not be installed in TRs.

### 2.5.4 Room Door.

The TR doors must be a minimum of 36 in (1 m) wide, 80 in (2 m) tall, without doorsill, hinged to open outward, and be fitted with a lock to control access to the room.

### 2.5.5 Room Location.

The TRs must be dedicated spaces not shared with other functions (i.e., electrical rooms, mechanical rooms, etc). The TRs should be located centrally in the area they serve. The TRs must be located such that maximum copper cable distance from the patch panel through the structured cabling system to the furthest outlet does not exceed 295 feet. In rehabilitation projects, rooms containing transformers, air handling units, etc., should be avoided if at all possible. If shared facilities cannot be avoided, ensure that proper electrical/telecommunications cable separations are maintained per National Electric Safety Code (NESC) and National Electric Code (NEC).

### 2.5.6 Telephone Backboards.

A minimum of one wall should be covered with rigidly fixed 3/4 inch (20 mm) A-C plywood, preferably void free, 8 feet (2440 mm) high, capable of supporting attached equipment. Plywood must be fire-rated. Fire rated backboards are TIA/EIA approved and are easier to field verify than the fire retardant paint. When renovating an existing closet that does not have adequate space, the backboard must be sized as large as possible to accommodate the PET and 110-type blocks. See Figure B-5 and B-6 of Appendix B for sample backboard layouts.

### 2.5.7 Equipment Racks.

Equipment racks must be floor mounted 19 inches (475 mm) wide located at or near the center of the TR. If mounting requirements for oversize equipment are anticipated, 23 inches (580 mm) may be substituted. In narrow or crowded closets, equipment racks may be floor mounted adjacent to a wall, but must provide a minimum 36 inches (900 mm) space both in front and behind the rack, behind any installed equipment, and a minimum side clearance of 24 inches (600 mm) on end racks. Provide 100 percent spare rack capacity based on the amount of rack capacity utilized by the patch panels provided. Spare racks must be provided for the mounting of government purchased and installed LAN equipment. Wall mounted racks may be utilized in small buildings or for small systems.

### 2.5.8 Equipment Cabinets.

Equipment cabinets should be used where physical security is required, to mount secure or mission critical equipment, in circumstances where controlled access is desired, such as CATV or CCTV, distribution in barracks, or by specific user request. Cable may be terminated in an enclosed 19-inch (475 mm) cabinet to provide enhanced protection for terminations and patching facilities. Cabinets must provide, at a minimum, sufficient space for current and anticipated future equipment requirements. Equipment cabinets may be floor or wall mounted and should be logically grouped based on the purpose of the equipment they enclose. Cooling fans must be provided in all equipment cabinets.

### 2.5.9 UTP Patch Panels.

The UTP patch panels should be installed in, or adjacent to, the equipment racks or cabinets, which will house LAN equipment. Patch panels should consist of eight-position modular jacks, with rear mounted type 110 insulation displacement connectors, category rated for the UTP system being installed, and arranged in rows or columns on 19-inch (475 mm) rack mounted panels. Nineteen-inch (475 mm) wall mounted may be utilized when necessary. Jack pin/pair configuration must be T568A per EIA ANSI/TIA/EIA-568-B. The modular jacks must conform to the requirements of EIA ANSI/TIA/EIA-568-B, and must be rated for use with the installed cable plant. Provide a minimum spare capacity of 10 percent in the installed patch panels.

### 2.5.10 FOPPs.

Fiber optic patch panels should be installed in, or adjacent to, the equipment racks or cabinets, which will house LAN equipment. Patch panel connectors and couplers must be the same type and configuration as used elsewhere in the system. Utilize 568SC duplex connectors on 19-inch (475 mm) rack mounted panels, unless otherwise directed. Twenty-three inch (580 mm) rack mounted panels, or minimum 12x10 in (300x250 mm) wall mounted enclosures may be utilized when necessary, such as at small facilities in U.S. Army projects. A 3-ft (1-meter) slack loop of fiber must be provided within each panel, and panels must provide strain relief for cables. Patch panels must properly provide termination, splice storage, routing, radius limiting, cable fastening, storage, and cross-connection. Provide a minimum spare capacity of 10 percent in the installed patch panels.

### 2.5.11 Ladder and Wire Cable Tray.

Ladder type or welded wire cable tray must be used in the TR to provide distribution between the telephone backboard, equipment racks, backbone conduits, and the distribution cable tray.

### 2.5.12 Room Lighting.

Light fixtures must be mounted a minimum of 9 feet (3 meters) above the finished floor and provide a minimum of 50 ft candles (500 lx) of illumination measured 3 feet (1 meter) above the finished floor.

### 2.5.13 Room Climate Control.

Each TR must be independently climate controlled, capable of providing year round ambient temperature control (24 hours/day, 365 days/year) to protect all installed electronic equipment. Rooms must be provided with positive atmospheric pressure to exclude dust. The designer must consult with the mechanical designer or facilities engineer if the TR is to house blade servers, PoE, or large numbers of network switches. These devices can generate a considerable amount of heat; therefore, the mechanical designer may have to compensate for these additional loads.

### 2.5.14 Room Contaminants.

Information system equipment must not be installed in spaces where moisture, liquid or gaseous spillage, or other contaminants may be present.

### 2.5.15 Electrical Power.

Provide a minimum of two dedicated 120 volt, 20-ampere duplex receptacles in each TR. Each receptacle must be on a separate 20-ampere branch circuit serving only that receptacle. Additional convenience receptacles must be provided at 6 feet (1800 mm) intervals around the perimeter walls. For all projects, provide a dedicated 20-ampere circuit and a quadraplex receptacle for each 19 inches (480 mm) rack or cabinet. The designer must consult with the electrical designer or facilities engineer if the TR is to house blade servers, PoE switches, PoE mid-span hubs, or large numbers of network switches. The designer should determine estimated power draw of these devices. The electrical designer may have to compensate for the considerable current draw amount of these devices.

Design note for renovations: The designer must specify a disconnecting means as defined in the NEC, Article 645.10, if the existing panel is not collocated or in close proximity of the branch-circuit power panel.

### 2.5.16 Voice Communications.

Each TR should have one wall-outlet installed at or near the entry door for emergency or voice communications.

## 2.6 Grounding.

All unclassified TRs must be connected to the building earth electrode subsystem (EES) IAW MIL-STD-188-124-B for U.S. Army installations, and as clarified in the TG for USAISEC Lightning Protection, Power Quality Analysis, Grounding, Bonding, and Shielding (LPAGBS). Information on grounding of classified facilities can be found in MIL-STD-188-124-B and Military Handbook (MIL-HDBK)-419-A. **Figures 10 and 11 of** Appendix C provide detailed schematics for the signal grounding system. An acceptable grounding system encompasses: fault protection grounds, lightning protection grounds, signal reference grounds, and direct current (DC) power grounds (when applicable). Refer to NFPA 780 and MIL-HDBK-419-A for proper lightning protection and NFPA 70 for proper fault protection grounding. The telecommunications designer must review project drawing to ensure that the lightning and fault protection grounds are addressed by the appropriate disciplines. The telecommunications designer must ensure that the different grounding systems are not mixed within the building.

### 2.6.1 Building Earth Electrode Subsystem (EES).

The building EES forms the primary electrical, life-safety grounding system. Typically, a grounding electrode conductor connects the main building-grounding electrode to the main electrical entrance panel or cabinet. NFPA 70, Article 250 Section III provides guidance on the grounding electrode system and conductor. End user buildings (EUB) and area distribution nodes (ADN) should have a resistance-to-earth of 10 ohms or less, following MIL-STD-188-124-B. The switch manufacturers may specify the resistance-to-earth as 5 ohms or less for a telephone switch or DCO. The designer should be conscious of the proposed utilization of the facility and plan accordingly. Sites must provide proper supporting documentation and specifications to the designer to support resistance-to-ground requirements more stringent than that of NFPA 70 or MIL-STD-188-124-B for non-voice switch buildings. Proper documentation includes international, national or local codes, DOD and DA standards, or manufacturers' equipment specifications.

### 2.6.2 Cable Entrance Grounding.

All metallic shields and strength members for OSP cable entering a building must be connected to the lightning protection ground system. The designer must ensure that the lightning protection is IAW MIL-STD-188-124-B and NFPA 780, *Standard for the Installation of Lightning Protection Systems*, latest issue.

#### 2.6.2.1 Building Point of Entrance.

The NFPA 70 defines the point of entrance as the location where "the wire or cable emerges from an external wall, from a concrete floor-slab, or from a rigid metal conduit or an intermediate metal conduit (IMC) grounded to an electrode IAW 800.400-B." The Telecommunications Entrance Facility (TEF) is the space housing the point of entrance of the telecommunications service.

#### 2.6.2.2 Copper Cable Entrance.

The OSP copper cable shield, armor, and metallic strength member must be bonded to the Lightning Protection Subsystem as close as possible to the building point of entrance with a No. 6 AWG or larger ground wire. The designer should use a non-bonded splice case for the transition from OSP rated cable to interior rated cable, or must indicate that the implementer not install the splice case carry-through bonding conductor. If the designer must extend the OSP copper cable past 50 feet (15 m) IAW NFPA 70 Section 800.50, the metallic strength member must be bonded to the lightning protection ground as close as possible to the conduit egress point with a No. 6 AWG or larger copper ground wire.

#### 2.6.2.3 Fiber Cable Entrance.

The OSP FOC armor and metallic strength member must be bonded to the Lightning Protection Subsystem as close as possible to the building point of entrance with a No. 6 AWG or larger ground wire. The designer should use a non-bonded splice case for the transition from OSP rated cable to interior rated cable, or must indicate that the implementer not install the splice case carry-through bonding conductor. If the designer must extend the OSP fiber cable past 50 feet IAW NFPA 70 Section 770.50, the metallic strength member must be bonded to the lightning protection ground as close as possible to the conduit egress point with a No. 6 AWG or larger copper ground wire. If inside/outside cable is used, a cable shield isolation gap must be incorporated.

#### 2.6.2.4 Copper Protector Block.

All OSP copper cables must be terminated on primary protector blocks, equipped with 5-pin solid state or gas protector modules. The protector blocks must be bonded to the Lightning Protection Subsystem with a No. 6 AWG or larger copper ground wire. Blocks must be UL listed. Place the protector block as close as possible to the lightning protection ground.

### 2.6.3 Telecommunications Room Signal Ground.

All TRs must have a high frequency signal ground designed IAW MIL-STD-188-124-B. The signal ground should consist of a ground plane in the room, a ring around the inside perimeter of the room for TR, or a ground bus bar for telecommunications closets. The signal ground ring or bar should be connected to the building EES by using the building steel girders or a ground cable if the girders are not accessible. The size of the grounding electrode conductor of a grounded or ungrounded alternating current (AC) system must not be less than given in National Electrical Code (NEC) Table 250.66. The values in NEC Table 250.66 are based on the size of the service-entrance conductors, but the grounding electrode conductor is not required to exceed 3/0 AWG copper or 250-kcmil aluminum. The telecommunications designer must ensure that the different signal grounding system does not interconnect with the fault protection and lightning protection sub-systems within the building.

### 2.6.4 Telecommunications Rack and Supporting Structure.

All telecommunications racks and supporting structures (cable trays, ladders, conduits, and baskets) within a TR must be bonded to the TR signal ground plane, ring, or bus bar as defined in and TIA/EIA-569-B.

## 2.7 Telecommunications System Labeling.

The following subparagraphs pertain to patch panel, distribution facilities, and outlet labeling.

### 2.7.1 Outlet/Patch Panel Labels.

The telecommunications systems labeling must be done IAW TIA/EIA-606-A. All outlets and patch panel positions must be labeled as to their function and with a unique identifier code. All devices, outlet locations, and designations must also appear on the system drawings. As a minimum the following must be reflected in the outlet/patch panel labeling:

- Security Level (if applicable)
- Room Number
- Alpha or Numeric Designator
- Labeling must be a minimum of ¼-inch (6mm) high
- Handwritten labels must not be used for the final configuration

### 2.7.2 Conformance to Existing Standards.

It is desirable that the labeling system conforms to any existing labeling, to the DOIM standard, or if neither exists to the method described above. All designations must be done in standard commercial labeling. Handwritten labels must not be used for the final configuration.

### 2.7.3 Telecommunications Outlet Labeling.

Outlet labeling must be done IAW TIA/EIA-606. Each outlet location must be labeled with a unique designator and level of classification, in sequence starting with “A” or “1” and proceeding clockwise around the room. The left or top 8-pin (RJ-45 type) Cat 6 or compliant connector should be designated for voice and be labeled "VOICE." The right or bottom 8-pin (RJ-45 type) Cat 6 compliant connector should be designated for data and be labeled "DATA.” All LAN components in the system must also be labeled with similar designations IAW TIA/EIA 606. For FO connections, the left or top FO connection should be labeled "A" and the right or bottom FO connection should be labeled "B."

### 2.7.4 Telecommunications Patch Panel Labeling.

Patch panel labeling must be done IAW TIA/EIA 606. Each position must be labeled with a unique designator corresponding to the outlet location. In addition to TIA/EIA-606-A requirements, the top or left 8-pin (RJ-45 type) Cat 6 compliant port for each outlet location should be designated for voice and be labeled "VOICE." The bottom or right 8-pin (RJ-45 type) Cat 6 compliant port for each outlet location should be designated for data and be labeled "DATA." Fiber optic port labeling must be done IAW TIA/EIA 606. The left or top connection should be labeled "A." The right or bottom connection should be labeled "B." Color-coding IAW TIA/EIA-606-A may be added to the labeling.

### 2.7.5 Distribution System Labeling.

The distribution system is described in TIA/EIA-606-A for pathways. In addition, all transitions and changes in distribution system size and type must be labeled. Each cabinet must be labeled at the top with a unique designation.

## 2.8 Building Entrance Facility.

The building entrance facility (equipment room) is the demarcation point between the OSP cabling and the inside plant distribution cabling.

### 2.8.1 Telecommunications Entrance Facility (TEF).

The TEF is the space housing the point of entrance of the telecommunications service. The TEF is also the space where the inter- and intra-building backbone facilities join. Telecommunication-related antenna entrances and electronic equipment may also be located in the TEF.

### 2.8.2 PETs.

#### 2.8.2.1 Protector Modules.

The PET must be equipped to protect the inside plant wiring and equipment from power surges. The PET must be provided with TIA/EIA-568-B compliant 110 type connector blocks or cable stubs to terminate on 110 type connector blocks.

#### 2.8.2.2 Sheath Limitations.

If the OSP sheath distance from the building entrance point to the PET or FO connector housing location is greater than 50 cable feet (15 m); the use of EMT is required.

#### 2.8.2.3 Stencils.

All PETs must be stenciled with the terminal number and cable count.

### 2.8.3 Fiber Termination Device.

The OSP FOCs are terminated on optical patch panels. The inside plant FO backbone cables are terminated on optical patch panels in the same or adjacent equipment racks. Patch cables are connected between the patch panels to provide the desired connectivity. All patch panels must be stenciled with the panel number and the cable count.

### 2.9 Testing.

The designer must specify that all telecommunications cable, installed as part of a project, be tested to the commercial standards for that cable system.

### 2.9.1 UTP Tests.

All metallic cable pairs must be tested for proper identification (ID) and continuity. All opens, shorts, crosses, grounds, and reversals must be corrected. Correct color-coding and termination of each pair must be verified in the communications closet and at the outlet. Horizontal wiring must be tested from and including the termination device in the communications closet to, and including the modular jack in each room. Backbone wiring must be tested end-to-end, including termination devices, from terminal block to terminal block, in the respective TCs. These tests must be completed and all errors corrected before any other tests are started.

### 2.9.2 Cat 6 Circuits.

All Cat 6 circuits must be tested using a test set that meets the accuracy requirements of ANSI/TIA/EIA-568-B.1 and ANSI/TIA/EIA-568-B.2-1. All test requirements must be completed as specified in ANSI/TIA/EIA-568-B.1 and ANSI/TIA/EIA-568-B.2-1.

### 2.9.3 Coaxial Cable.

Cable must be tested for continuity, shorts, and opens. Characteristic impedance must be verified over the range of intended operation. Cable length must be verified. Cable must be sweep-tested for attenuation over the range of intended operation.

### 2.9.4 FOC.

All category FO circuits must be tested using a test set that meets the accuracy requirements of ANSI/TIA/EIA-568-B.1 and ANSI/TIA/EIA-568-B.3. All test requirements must be completed as specified in ANSI/TIA/EIA-568-B.1 and ANSI/TIA/EIA-568-B.3.

Unless stated otherwise, tests must be performed from both ends of each circuit. Connectors must be visually inspected for scratches, pits, or chips and must be re-terminated if any of these conditions exist.

## 3.0 OUTSIDE PLANT TELECOMMUNICATIONS CABLING SYSTEM SPECIFICATIONS.

This document provides engineering and installation standards for OSP infrastructure for projects that support the core enterprise information infrastructure at Army posts, camps, bases, and stations worldwide. The OSP System is designed to satisfy I3A policy IS requirements on a facility. System design, integration, and quality assurance (QA) services are also part of this documentation. The OSP must be installed IAW the specifications referenced within this document, with modifications and clarifications provided below. Telecommunications design should be performed and stamped by a RCDD. This OSP section is synchronized with UFC 3-580-2, Telecommunications Systems Outside Plant

Cabling System Planning and Design. The objective of this UFC is to provide planning guidance for the development of an input to the building cabling system telecommunications portion of the DD 1391. The UFC-3-580-2 is designed to satisfy U.S. Army I3A policy or UFC 3-580-10 Design: NMCI Standard Construction Practices IS requirements within a facility.

### 3.1 Classified Information Infrastructure.

Engineers engaged in the design of classified (collateral or higher) Information Infrastructure must coordinate the infrastructure design with the CTTA and DAA responsible for that area. This TG cannot attempt to replace the publications that were produced to support the design of Red/Black infrastructure. The engineer must consult the following applicable documents for consideration and design guidance. If a hardened carrier distribution system (HCDS) is implemented, as detailed in the design drawings, the HCDS should only include the HCDS, the fiber, and a lock box or cabinet. The HCDS hand holes and maintenance holes (MH) must be considered part of the HCDS system and are expected to be fully compliant with NSTISSI 7003. Specifically, the walls of the installed HCDS hand holes and/or MHs must meet or exceed the minimum requirements for encasing the HCDS. If a CTTA review is required, and the review determines that TEMPEST countermeasures are required, the CTTA must consider a variety of methods that can be applied to the system/facility to achieve TEMPEST security. The RED/BLACK guidance contained in NSTISSAM TEMPEST/2-95 (For Official Use Only (FOUO)) must be considered by the CTTA along with other measures (e.g., TEMPEST Zoning, TEMPEST suppressed equipment and shielding) to determine the most cost-effective countermeasures to achieve TEMPEST security. Only those RED/BLACK criteria specifically identified by the CTTA must be implemented. Additional information on grounding can be found in MIL-STD-188-124-B and MIL-HDBK-419-A. Information on Protected Distribution Systems can be found in NSTISSI No.7003, 13 December 1996.

### 3.2 System Overview.

Items included under OSP infrastructure are MH and duct, copper cable, FOC, MDF, terminations, cable vaults, multiplexing equipment, environmentally controlled housings, cross-connects, and copper and FO entrance cable.

### 3.3 System Architecture.

The DOD currently employs a number of architecture topologies for the design of OSP. These topologies include ring, star, and mesh configurations. These topologies are based upon telephone or dial central offices CO/DCO, main communications nodes (MCN) and ADNs, and EUBs. The DOID is also spearheading the effort to converge voice and data over the same transport layer. In which case, the nodes are designated as converged distribution nodes (CDN). Connectivity between nodes, and from the nodes to EUBs, provides the post transport backbone. The OSP designer must design the OSP infrastructure to support the topology of the service that has authority over the construction project.

#### 3.3.1 Minimum New Cable Requirements.

If the design requires installation of new cable, the following minimum requirements apply:

##### 3.3.1.1 MCN to MCN.

For planning purposes, use a minimum of 48 strands of single-mode FOC between MCNs to provide load balancing, network reliability, and growth.

#### 3.3.1.2 MCN to ADN/ADN to ADN.

Design a minimum of 24 strands of single-mode FOC between the ADN and MCN. Design a minimum of 24 strands of single-mode FOC between each ADN and two adjacent physical ADN locations, or to one ADN and one MCN location.

#### 3.3.1.3 ADN to EUB.

Design a minimum of 12 strands of single-mode FOC to connect a EUB with less than 200 users to an ADN. Design a minimum of 24 strands of single-mode FOC to connect a EUB with between 200 and 600 users to an ADN. Design a minimum of 24 strands of single-mode FOC from a EUB with more than 600 users, to an ADN location, plus four additional strands for 100 user increments above 600 users, up to 48 strands.

### 3.3.2 CCN/CDN Cable Paths.

The physical path of the cable from a physical ADN location to each adjacent MCN/ADN should be directly to the connected MCN/ADN without routing through or patching through any other building, with the exception of stand-alone cable huts or vaults.

#### 3.3.2.1 Copper.

The number of OSP copper pairs is calculated by multiplying the number of users or jumpers in the building times 1.5 pairs. This factor must add in some additional pairs for faxes, modems, and special circuits. The cable is then sized to the nearest logical standard cable size. For example, a building with 85 users would require a 200-pair cable (85 x 1.5 = 128 ➔ 200 pair).

### 3.3.3 Redundant Cable Paths.

The backbone networks are normally constructed with a concrete encased path so that a single cable cut cannot isolate any core node or critical node from other core nodes. The user must present official justification to have two physically diverse cable routes from a EUB location to a node location. Justification includes DOD directives and DAA certification.

## 3.4 Outside Plant.

This section contains the engineering, installation, and material guidance for the installation of OSP infrastructure and electronics. An overall schematic for OSP sizing of duct and cable is provided in Figure C-1 (Figure C-9 for Europe) – OSP Infrastructure Standards.

## 3.5 Environmental and Historical Considerations.

Most military installations contain areas that may be affected by environmental or historical matters. Environmental hazards may include toxic waste, fuel spillage/leakage, asbestos, unexploded ordnance, etc. Wildlife preservation may be another area of concern at some sites. Compliance with historical restrictions must require special engineering considerations (type of exterior facing, mounting of terminals, placement of pedestals, etc.). These types of situations must be further defined in the design package. Disposal of waste materials must be accomplished by the installer IAW the site's documented procedures for clean and/or environmentally hazardous material as specified in the design package.

### 3.5.1 Price of Conformance.

Although these issues may not appear to have a high impact on the engineering solution, the price of conformance to site restrictions may add considerable cost to the project. Special conditions should be discussed with the DOIM and agreements documented.

## 3.6 General Considerations.

### 3.6.1 Digging Permits.

The installer must coordinate with the site Directorate of Public Works (DPW) to schedule all excavation and obtain the required digging permits. Permission (approved digging permits) must be obtained from the site prior to the start of any excavation and/or construction.

### 3.6.2 Utility Location.

The DOIM or DPW must be responsible for the location and marking of the utilities, unless otherwise stated in the design package. The installer must furnish a schedule of proposed excavation involving utility locations to the DOIM/DPW in sufficient time to allow marking. Since each DOIM/DPW has different operating requirements, the location lead-time must be stated in the design package. An acceptable utility mark must be within 24 inches (600 mm) of the edge of the utility. After the utilities are located and marked, the installer is responsible for maintaining the marks until they are no longer required. The intent is that the utilities must be located and marked only once and not after each rainfall.

### 3.6.3 Pot Holing.

The installer, either U.S. Government or contractor, is responsible for positively determining the exact location and depth of all marked utilities suspected to be within 24 inches (600 mm) of the proposed excavation or directional drilling by hand digging and/or pot holing to ensure the trenching or boring/drilling equipment does not damage the utilities. The installer should create an initial hole no larger than 12 in x 12 in (300 mm x 300 mm), when pot holing in road surfaces prior to boring operations. However, the installer may increase the hole in size as needed to determine the exact size and depth of the utility being located.

### 3.6.4 Slot Trenching.

With the approval of the U.S. Government, the installer may use vacuum excavation equipment to dig slot trenches. Slot trenches may be used for the installation of conduit or cable through congested areas having poorly marked utilities that cannot be avoided by adjusting cable routes.

### 3.6.5 Road Crossings.

The designer must plan the cable route to cross the road only as necessary to serve subscribers without the use of aerial inserts. Such crossings must be constructed by cutting or sawing perpendicularly across the road, by trenching perpendicularly across the road, by directional boring under the road, or by pipe pushing under the road. Pavements must not be cut where the traffic detection wires of traffic light control systems are embedded.

### 3.6.6 Cuts and Resurfaces.

Cuts should typically extend at least 6 inches beyond either side of the trench to provide a stable base for the surface material, unless otherwise directed by the design package. Roads, streets, parking lots, etc., should only be closed for as long as is required to complete the work required to place the duct (including tamping the backfill) and allow the slurry, concrete, and/or asphalt to properly set IAW manufactures specifications.

Once the concrete or slurry has set, the surface must be restored to original conditions within 72 hours, unless otherwise approved by the government. Certain streets or roadways may have cutting restrictions or special requirements that require traffic be resumed as soon as possible. Contractors must be prepared to comply with these restriction and requirements. Steel plates may be used as an option to open the street to traffic while the material is curing.

#### 3.6.6.1 Dowels.

Construction joints resulting from restoration in concrete pavement in excess of 180-mm (7-inches) thick or subjected to heavy vehicle traffic must be doweled. Dowels may be required in thickness of less than 7 inches (180-mm), as specified by the DPW or equivalent.

#### 3.6.6.2 Right-of-Way Permits and Easements.

The U.S. Government must verify and document that for any crossing requiring a right-of-way permit or easement, such permit must be available to the installer. The installer must be responsible for obtaining the appropriate permits and approvals in a timely manner to ensure compliance with established completion dates.

### 3.6.7 Materials.

The following are materials that may be encountered.

#### 3.6.7.1 Rock.

Rock must consist of boulders measuring 1/2-cubic yard ($yd^3$) (0.382-cubic meter [$cm^3$]) or more, or other material such as rock in ledges, bedded deposits, un-stratified masses, and conglomerate deposits, or below-ground concrete masonry structures, that cannot be moved without systematic drilling and blasting or the use of a rock saw. Pavements must not be considered as rock. Excavate rock to a minimum of 4 inches (100-mm) below the trench depths required to place the duct bank or cable. The installer must backfill the rock excavation and all excess trench excavation with a cushion of sand at least 4 inches (100-mm) prior to placing the duct or cable. Refer to Unified Facilities Guide Specifications (UFGS) UFGS-02300, Earthwork, for additional excavation details.

#### 3.6.7.2 Unstable Soil.

When wet or otherwise unstable soil that is incapable of properly supporting the conduit or MH is encountered in the trench bottom, the installer must, at no additional cost to the U.S. Government, remove such soil to the depth required; establish a sound base, and backfill the trench to trench bottom grade with coarse sand or fine gravel. The site U.S. Government representative must determine if the soil is unstable. Refer to UFGS-02300, Earthwork, for additional details on trenching. Applicable safety procedures Occupational Safety and Health Administration (OSHA), host nation, and local) must be followed for shoring or sloping.

#### 3.6.7.3 Select Backfill.

The direct buried (DB) duct system must be buried in layers of select backfill whenever the DB duct system is not concrete encased. The backfill must be placed IAW commercial standards and UFGS-02300, Earthwork, whichever is more stringent. The installer must obtain the signature of the on-site U.S. Government quality control (QC)/QA representative, signifying the acceptability of the duct placement and spacing, prior to placing any backfill over the duct.

#### 3.6.7.4 Flowable Fill or Slurry.

The portion of the trench above concrete-encased duct systems under roads and parking lots must be backfilled with flowable fill, also known as slurry. The flowable fill must have a compression strength rated between 50 to 100 pounds per square inch (lb/in$^2$) (345 and 689 kilopascal [kPa]). Flowable fill must not be used as a substitute for concrete encasement.

### 3.6.8 Backfilling.

In accordance with UFGS-02300, Earthwork, all excavated areas around the new MHs, ducts, or cables must be backfilled with approved excavated materials consisting of earth, loam, sandy clay, sand, gravel, and soft shale free from large clumps.

#### 3.6.8.1 Placement.

Backfill materials must be deposited and tamped in 6-inch (150-mm) layers until the conduit has a cover of not less than 1 ft (300 mm). The remainder of the backfill materials must be placed into the excavation and then tamped in 1-ft (300-mm) layers. The earth must be graded to a reasonable uniformity, mounded, and left in a uniform and neat condition.

#### 3.6.8.2 Unsatisfactory Materials.

Blasted rock, large boulders, broken concrete, or pavement must not be used as backfill materials.

#### 3.6.8.3 Other Materials.

A slurry or flowable fill type backfill can be used in lieu of a tamped backfill. The slurry or flowable fill must have a compression strength rated between 50 to 100 lb/in2 (345 and 689 kPa) once it has set up. Flowable fill must not be used as a substitute for concrete encasement.

### 3.6.9 Restoration.

Restoration to the same condition as found prior to construction must be completed within 72 hours for all areas where no additional intrusion is required. Roads, streets, parking lots, etc. should only be closed for as long as is required to complete the work and allow the slurry, concrete, and/or asphalt to properly set IAW the manufacturers' specifications. Certain streets or roadways may have cutting restrictions or special requirements that require that traffic be resumed as soon as possible. Designers should ensure that the contractors are prepared to comply with these restrictions and requirements.

#### 3.6.9.1 Improved Areas.

Roadways, walks, paved areas, and other surfaces disturbed by the installer must be resurfaced with same type of material and to the same thickness as the original surface. Roadways must have a minimum thickness of 3.5 inches (90 mm) of resurfaced pavement.

#### 3.6.9.2 Grass.

All grass surfaces must be leveled and reseeded, unless otherwise directed (such as the placement of sod) in the design package. For grassy areas where the installer must have to bring heavy equipment back onto the construction site, the areas must be rough graded and covered with protective matting to prevent erosion. For durations longer than two weeks between construction and final disturbance, the installer must rough seed the area to provide cover until final grading and seeding are accomplished.

#### 3.6.9.3 Dowels.

Construction joints resulting from restoration in concrete pavement in excess of 7-inches (180-mm) thick or subjected to heavy vehicle traffic must be doweled. Dowels may be required in thickness of less than 7 inches (180 mm) as specified by the DPW or equivalent.

#### 3.6.9.4 Cleanup.

Areas impacted by the installer’s construction (roads, sidewalks, parking lots, etc.) must be maintained free from waste, debris, washout, etc. The installer must clean any mud tracks built up on roads, parking lots, etc., or washouts within 24 hours or as specified by the U.S. Government.

### 3.6.10 Detection of Buried Cables and Underground Conduits.

#### 3.6.10.1 Warning Tape.

All warning tape must be polyethylene (PE) plastic tape, a minimum width of 150 mm (6 inches), IAW APWA Uniform Color Code, and imprinted with the words "WARNING - TELECOMMUNICATION CABLE BELOW” at not more than 1.2 m (48 inch) intervals. Minimum thickness of the tape must be 0.10 mm (0.004 in). Tape must have a minimum strength of 12.0 Megapascal (MPa) (1750 pounds per square inch (PSI))) lengthwise and 10.3 MPa (1500 PSI). Tape must be manufactured with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 920 mm (3 feet) deep. The materials in the warning tape must be chemically inert and will not degrade when exposed to acids, alkalis, and other destructive substances found in soil.

#### 3.6.10.2 Detection Wire for Non-metallic Piping.

Detection wire must be insulated, single strand, solid copper with a minimum of 12 AWG coated with a minimum 30 mm PE jacket designed specifically for buried use.

#### 3.6.10.3 Detectable Warning Tape Installation.

Detectable warning tape must be installed 305 mm (12 inches) to 405 mm (18 inches) above all new non metallic conduit formations and DB cable installations and must not exceed the manufacturer’s recommended depth below grade. Tape must be placed at a depth of no less than 310 mm (12 inches) below surface grade. Buried cables include cables placed in open trenches and cables placed by plowing.

#### 3.6.10.4 Permanent Tracer Wire.

Permanent tracer wire must be installed in all new duct banks (The conduits may contain a ton able cable today, but it might be removed in the near future). One tracer wire must be installed per duct bank. The tracer wire must be placed centrically as possible in the top conduit formation. When dielectric cable is installed in existing conduit formations that do not contain toneable cables, a tracer wire must be installed along with the dielectric cable.

Splices in the tracer wire must be connected by means of a compression type connector to ensure continuity. Wire nuts must not be used. After installation, tracer wire should be tested to verify continuity of the tracer wire system and a report indicating continuity should be submitted to the permitting authority as part of the as-built construction records.

## 3.7 Outside Plant Cable Placement Options.

Underground pathways and spaces may be dedicated for cable placement (e.g., DB cable, buried duct/conduit, MHs, hand holes, and shared space, such as a utility tunnel providing other services).

### 3.7.1 Underground.

An underground MH and duct system, as required due to utility congestion, high traffic, or high building density, must be used as the preferred method for placement of outside cable plant in new construction and rehabilitation within the site cantonment areas, unless otherwise specified in the design package. The existing MH and duct system must be leveraged to the maximum extent possible by the repair and reuse of damaged existing conduit runs and MHs (where economically feasible) and by reinforcing existing full conduit runs with new conduits. Existing MHs may be overbuilt to an adequate size with U.S. Government approval.

### 3.7.2 Direct Buried.

The DB cable plant system is the preferred method for placement in less congested areas.

### 3.7.3 Aerial.

Aerial cable plant systems must not be used except as specified in the design package. Exceptions may include range cables or other long runs through undeveloped areas, in cases where underground systems cannot be installed, or in conformance to local mandates. Aerial pathways and spaces may consist of poles, messenger wire, anchoring guy wires, splice closures, and terminals.

### 3.7.4 Pier and Bridge Telecommunications.

Pier and bridge telecommunication systems should be installed in ducts, with pull boxes placed at critical points. These critical points may be where the structure has a change of direction, where access for ship berths is required, or at a 90-degree bend. Duct expansion joints are required at each pier expansion joint; and where the conduit enters a distribution point approximately 5 feet (1.5 m) from the point of entrance. The designer should use polyvinyl chloride (PVC) covered Galvanized Iron Pipe (GIP), or "Red Thread" Fiberglass Conduit, employing approved hardware hangers, for conduit systems on piers.

## 3.8 Underground (Maintenance Holes, Cable Vaults, and Ducts).

Supporting documentation for the design and construction of MHs, cable vaults, and duct systems is found in ANSI/TIA/EIA-758, *BICSI Customer Owned Outside Plant Telecommunications Cabling Standard;* Rural Utilities Service (RUS) Bulletin 1751F-643/RUS Form 515C; RUS Bulletin 1751F-644; and RUS Bulletin 1753F-151. See Table 1 for the complete names of these references.

### 3.8.1 MHs.

Maintenance holes are used to facilitate placing and splicing of cables. Telecommunications MHs must not be shared with electrical installations other than those needed for the telecommunications equipment.

Maintenance holes are reinforced concrete units provided with a removable lid that permits internal access via ladder or rungs to the housed components. They accommodate cables, splice closures, racking systems, and low voltage electronic equipment. Maintenance holes must be equipped with corrosion-resistant pulling irons and cable racks that are grounded and a sump for drainage.

Maintenance holes must be installed on a leveled, crushed, washed, gravel base of sufficient depth, a minimum thickness of 6 inches (150 mm) under the entire MH, to allow for drainage and stability. Where MHs are installed in roadways, the structure and lid (cover) must support heavy vehicular traffic. See Figure C-4 (Figure C-11 for Europe) – Typical Maintenance Hole for additional details.

#### 3.8.1.1 Types.

The preferred MH is a pre-cast reinforced concrete, splayed or non-splayed, multi-directional type with cast-in single or multiple plastic terminators to accept the conduits. Thin concrete knockout sections may be provided for terminating multiple-bore conduits. The preferred MH interior size is 12 ft x 6 ft x 7 ft [3.7 m (length) x 1.8 m (width) x 2 m (height)]. Other sizes may be used only with U.S. Government approval. Splayed MHs should be provided near DCOs and remote switching units (RSU), where future duct expansion is expected. Maintenance holes must have a load rating of H-20 for heavy vehicular traffic.

#### 3.8.1.2 Basic Layout.

Maintenance holes in main or lateral duct runs must not be placed more than 180m (600 feet) apart without prior approval of the U.S. Government. Measurements between MHs are from lid-to-lid (center-to-center) (C/C), unless otherwise indicated. Measurements from MHs to buildings, to pedestals, to riser poles, etc., are from the MH lid to the outside wall, bottom of pole, etc., (center-to-point). New MHs must be placed to support the locations of junction points, offsets, load points, and curvature in the duct line.

#### 3.8.1.3 Accessories.

Each new MH must be equipped with a lid, sump, pulling-in irons, ground rod, bonding ribbon, cable racks, and hooks. Accessories must be designed for use in a telecommunications MH. Cable hooks must be placed IAW RUS Bulletin 1751F-643, RUS Bulletin 1753F-151, and the *AT&T Outside Plant Engineering Handbook*, August 1994, Practices 632-305-215 and 919-240-300 to support the weight of the cable and splice case.

a. Maintenance Hole Lids – A MH must include a point of egress for maintenance personnel. The MH lid must be circular and not less than 30 inches (765 mm) in diameter and must not violate the H-20 load rating of the MH. Additional lids or oversized lids may be provided for MHs with special uses i.e., oversized MHs, MHs containing carrier or

b. loading equipment, or MHs located outside a DCO. The lid must fit in a steel ring or frame and be equipped with a concrete collar to be at grade level, as required. The frame and collar must be attached to the MH IAW the manufacturer's instructions, but as a minimum, the lid must form a watertight seal and must resist lateral movement if accidentally bumped.

c. Locking Covers – The first MH outside a DCO or wire node, MHs at critical junctions, or MHs equipped with carrier equipment will have lockable cover. Additional MHs may be identified as requiring lockable covers in the Statement of Work (SOW)/Engineering Design Plan (EDP). The preferred lockable lid cover is one that utilizes a lever and clamp mechanism placed into a receiver that is installed into the cover. The mechanism will allow the cover to be replaced without indexing the cover to the frame. When locked, the mechanism will be flush with the frame surface minimizing the potential for the cover to be dislodged. The bolt used to secure the cover is available in many configurations and can only be turned with a socket provided by the manufacturer. The U.S. Government will select the bolt configuration. A disposable tamper evident plastic cap snaps into the lock body covering the recessed bolt head keeping dirt and debris out of the bolt area. An alternative means of securing the MH utilizes an inner, water resistant cover that can be locked by a General Services Administration (GSA)-approved, changeable combination lock. The U.S. Government will provide the locks.

d. Sump – A sump must be cast into the floor of the MH. The floor must slope toward the sump to provide drainage from all areas into the sump. The sump must be approximately 13 in x 13 in (330 mm x 330 mm), or a 13-inch (330-mm) diameter circle, and must be 4 inches (100-mm) deep covered with a removable perforated or punched plate to permit drainage. The cover must be fastened to the housing by a chain, rope, or hinge.

e. Pulling-in Irons – Cable pulling-in irons must be installed on the wall opposite each main conduit entrance location, 3-1/2 to 9 inches (90-230 mm) from the floor of the MH and in line with the conduit entrance. The pulling-in irons must be placed and embedded during the construction of the MH wall.

f. Grounding in MHs – All new MHs installed must include ground rods and bonding ribbon. The ground rod and bonding ribbon may only be omitted when the following conditions apply:

(1) A MH is designed and constructed with an integral ground system with all ironwork bonded together.

(2) The MH is identified as containing an integral ground system with a manufacturer's label.

(3) U.S. Government approval is obtained.

All existing MHs that require new splices, or where existing splices are opened, must be bonded and grounded. If no bonding ribbon and ground rod exist, then they must be installed and all other existing splice cases must be bonded and grounded. New cables installed in MH and conduit systems must be bonded and grounded a minimum of every 1,000 feet (305 m). In accordance with RUS 1751F-802 and NEC, Article 250, the resistance for OSP grounding must be nominally 25 ohms (Ω).

f. Ground Rod – A Ground Rod of iron or steel that is galvanized or copper clad at least 5/8-inch (16-mm) in diameter and at least 9-feet (2.75 m) long must be installed in the floor of each new MH. Four inches (100-mm) of the rod, plus or minus 1/2 inch (1.3 mm) must extend above the finished floor level. The rod must not enter the MH more than 3 inches (80 mm) or less than 2 inches (50 mm) from the vertical surface of the adjacent wall. All MH splices must be bonded to the MH ground. In existing MHs, new ground rods and/or bonding ribbon must be designed at each splice location if none presently exists. The ground rod must be installed and bonded IAW the NEC, Article 250.

g. Bonding Ribbon – A bonding ribbon must be installed in all new MHs. The bonding ribbon must be attached to all rack anchors and be pre-cast into the MHs. The bonding ribbon must be installed around the interior of the MH so that splice cases can be bonded to it.

h. Hardware – A minimum of five cable racks, each containing at least 47 hook spaces mounted vertically, must be provided on each long wall. Two of the cable racks must be installed flush to the wall and three with standoffs to create splice bays (Figure C-4 [Figure C-11 for Europe]). End wall MH racks must be provided at the T-end of multi-directional MHs. Corner racks must be provided at the in-line end of the MH. Offset-cable racks must set out from the wall a minimum of 3 inches (80 mm). Each cable rack must be equipped with hooks to support all existing or new cables. If there are no existing/new cables, each rack must be equipped with two cable hooks (minimum length 7-1/2 inches (190 mm). All racks and hooks must be of galvanized metal. Figure C-4 (Figure C-11 for Europe) – Typical Maintenance Hole shows a typical rack installation.

i. Water Resistance – Reasonable efforts must be taken to prevent water from entering a telecommunications MH. The manufacturer's instructions for installing a MH must be followed. As a minimum, the following guidance must apply as long as it does not violate a manufacturer's recommendations or warranty. Additional requirements may be identified in the design package.

(1) A water resistant gasket or seal must be placed between the sections of pre-cast MHs.

(2) Water resistant gaskets or seals must be placed between the lid frames, collars, and MH tops.

(3) The area around ducts penetrating the MH walls must be sealed with a permanent water-resistant material.

(4) Vacant ducts must be sealed with a mechanical, screw-type, reusable duct plug.

(5) Ducts containing cables must be sealed with water-blocking foam or other recommended sealants designed for this purpose.

(6) Ducts containing innerduct or multi-cell fabric mesh innerduct must be sealed with manufacturer's recommended materials or methods.

#### 3.8.1.4 Duct Assignment and Cable Racking.

Duct assignment and cable racking must be engineered and installed IAW the *AT&T Outside Plant Engineering Handbook*, August 1994, Practices 632-305-215 and 919-240-300, and standard drawings, unless otherwise directed in the design package. Copper cables must be racked to the MH sidewalls in such a manner so as to make the best use of the wall space available. When placing cables care should be taken so as to avoid blocking ducts in the sidewalls or access to splice cases. Fiber optic cables will be engineered with enough slack so that a 6-m (20-feet) service loop can be installed in each pull through MH or a 15-m (50-feet) splice loop on each cable installed into a splice case. The service and splice slack must be coiled and lightly secured in loops that do not violate the bending radius and placed in the MH in such a manner that the cables are out of the way and not wrapped around other cables.

#### 3.8.1.5 Stencil.

All new MHs must be stenciled with a number designated by the DOIM.

#### 3.8.1.6 Depth of Cover.

A minimum of 24 inches (600 mm) of top cover must be provided above the top of the MH.

### 3.8.2 Hand Holes.

Hand holes are reinforced concrete units provided with a lid that permits internal access to the housed components. Hand holes are typically used as pull points for small diameter cables for building access. A hand hole must not be used in place of a MH or in a main conduit system. Hand holes must not be used for splicing cables without prior U.S. Government approval. Telecommunications hand holes must not be shared with electrical installations. The minimum hand hole size is 4 ft x 4 ft x 4 ft (1.2 m x 1.2 m x 1.2.m). Larger hand holes (i.e., 1.2 m x 1.8 m x 1.2 m) are acceptable. Hand holes installed where vehicle traffic may be present must be load rated as H-20 and must be equipped with round MH lids.

#### 3.8.2.1 Accessories.

Each new hand hole must be equipped with a lid, pull irons, cable racks, and hooks designed for use in telecommunications systems. Cable hooks must be placed to support the weight of the cable.

#### 3.8.2.2 Stencil.

All new hand holes must be stenciled with a number designated by the DOIM.

### 3.8.3 Cable Vault.

A schematic of an MDF and cable vault is provided in Figure C-8 (Figure C-15 for Europe) – MDF and Cable Vault Schematic.

#### 3.8.3.1 Size.

The cable vault must be sized to provide for future projected growth. As a minimum, it must extend the entire length of the MDF.

#### 3.8.3.2 Layout.

A center rack must be provided for the splicing of the tip cables to the OSP cables. However, wall racking, if cited in the design package, is allowable for small to medium central offices. The vault must be designed to allow ample space for splicing of the cables. For planning, a typical vault splice is 1 ft x 3 ft (300 m x 900 m).

### 3.8.4 Conduit/Duct.

Underground conduit structures consist of pathways for the placements of telecommunications cable between points of access. Underground installation of ducts/conduits must be achieved by trenching, boring, or plowing.

a. Examples of conduit types include:

- Encased Buried (EB)-20 – for encasement in concrete
- EB-35 – for encasement in concrete
- DB-60 – for direct burial or encasement in concrete
- DB-100 – for direct burial or encasement in concrete
- DB-120 – for direct burial or encasement in concrete
- Rigid Nonmetallic Conduit Schedule 40 – for direct burial or encasement in concrete
- Rigid Nonmetallic Conduit Schedule 80 – for direct burial or encasement in concrete
- Multiple Plastic Duct (MPD) – for direct burial or installation in conduit
- Rigid Metallic Conduit – for direct burial or encasement in concrete
- Intermediate Metallic Conduit – for direct burial or encasement in concrete
- Fiberglass Duct – for direct burial or encasement in concrete
- Innerduct PE – for direct burial or installation in conduit
- Innerduct PVC) – for direct burial or installation in conduit
- High Density Polyethylene (HDPE) – for directional drilling
- EB-20 and DB-60 conduit must meet National Electrical Manufacturers' Association (NEMA) Standard TC-6
- EB-35 and DB-120 conduit must meet NEMA Standard TC-8
- Schedule 40 and Schedule 80 rigid nonmetallic conduit must meet NEMA Standard TC-2

b. Nonmetallic conduits must be encased in concrete of minimum 3,000 lb/in$^2$ (20,700 kPa) compressive strength where vehicular traffic (i.e., automotive, railway) is above the pathway, or where a bend or sweep is placed.

c. Spacers will be used to properly support ducts that are to be concrete encased and must be installed IAW the manufacturer's specifications. If the manufacturer's specifications are unknown, a spacer must be installed a minimum of one spacer every 10 feet (3 m). Ducts supplied in 20-feet (6.1-m) lengths require spacers every 5 feet (1.5 m). The duct must not be damaged, cracked, or crushed prior to or during installation. Conduit systems not encased in concrete must be installed in layers with backfill installed around and between the ducts. Spacers may be used where conduits are not encased in concrete to provide integrity of orientation. Construction vehicles must not be driven over DB conduits.

d. Ensure the integrity of the orientation of the duct bank between MHs. Do not allow the ducts to twist or tangle between MHs.

#### 3.8.4.1 Ducts Installed in Trenches.

The type of duct for new installation must be PVC, Schedule EB, DB, or Schedule 40. Schedule EB duct must be used only if the duct is encased in concrete. Schedule DB or Schedule 40 duct must be used for applications where the duct is DB or encased in concrete.

#### 3.8.4.2 Joints and Connectors.

Ducts must be joined in such a manner as to be soil tight. Joints must form a sufficiently smooth interior surface between joining sections so that cables must not be damaged when pulled past the joint. Joints between dissimilar types of ducts (PVC, HDPE, galvanized steel pipe (GSP), EB, DB, etc.) must use the appropriate connectors designed for the purpose of providing a seal between the ducts and preventing damage to cables pulled through these joints.

#### 3.8.4.3 Bends and Sweeps.

Accomplish changes in direction of runs exceeding a total of 10 degrees, either vertically or horizontally, by long sweeping bends having a minimum radius of 25 feet (7.62 m). Long sweeps may be made up of one or more curved or straight sections and/or combinations thereof. Bends made manually must not reduce the internal diameter of the conduit. There must be no more than the equivalent of two 90-degree bends (180 degrees total) between pull points, including offsets and kicks with a curvature radius of less than 100 feet (30 m). Back-to-back 90-degree bends must be avoided. The following definitions are explained:

a. Ninety-Degree Bend – Any radius bend in a piece of pipe that changes direction of the pipe 90 degrees.

b. Kick – A bend in a piece of pipe, usually less than 45 degrees, made to change the direction of the pipe.

c. Offset – Two bends usually having the same degree of bend, made to avoid an obstruction blocking the run of the pipe.

d. Ninety-Degree Sweep – A bend that exceeds the manufacturer’s standard size 90-degree bend (e.g., 24 inches (600 mm) is standard for 4-inch (100-mm) conduit).

e. Back-to-Back 90-Degree Bend – Any two 90-degree bends placed closer together than 10 feet (3 m) in a conduit run.

Where the radius is less then 40-feet (12 m), 15-feet (4.6 m) radius-manufactured bends must be used. If possible, the entire change in direction should be made with a single arc of 15-feet (4.6 m) radius. Manufactured bends may be used on subsidiary/lateral conduits at the riser pole or building entrance. Manufactured bends must have a minimum radius of 10 times the internal diameter of the conduit IAW NEC Chapter 9 and ANSI/TIA/EIA-758.

Bends and sweeps must be concrete-encased to protect the duct from the pressures developed while pulling cables. Where a duct enters a building and sweeps up through a floor slab, galvanized RSC must be used. For ducts transitioning from the lower duct window of a MH to the nominal trench depth, the transition must be accomplished in no less than 30 linear feet (9.1 m) from the MH in order to reduce the radius of the bends. The duct should be concrete-encased in the transition area.

### 3.8.4.4 Section Lengths.

The section length of conduit must not exceed 600 feet (183 m) between pulling points in main conduit runs without U.S. Government approval. The section length of subsidiary duct is limited mainly by the size of the cable to be pulled into it and the number of bends it must contain. Table 3 lists the maximum section lengths.

**Table 3. Maximum Length of Subsidiary Conduit Containing Bends**

| Cable Diameter Mm (in) | Limited Lengths of Duct* | | |
|---|---|---|---|
| | One 90 Degree Bend (m) (ft) | Two 90 Degree Bends (m) (ft) | Three 90 Degree Bends (m) (ft) |
| 25.4 (1.0) | 182 (600) | 107 (350) | 76.2 (250) |
| 30.5 (1.2) | 152 (500) | 91.4 (300) | |
| 35.6 (1.4) | 122 (400) | 83.8 (275) | |
| 40.6 (1.6) | 107 (350) | 76.2 (250) | |
| 45.7 (1.8) | 91.4 (300) | 61 (200) | |
| 56 (2.2) | 76.2 (250) | 45.7 (150) | |
| 66 (2.6) or greater | 61 (200) | 45.7 (150) | |

*Bends may be vertical or horizontal. Reverse curves and the use of three 90-degree bends should be avoided.

### 3.8.4.5 Minimum Duct Bank Sizing.

The minimum sizing for new duct banks is listed below. The total number of conduits required must be determined, including existing conduits, conduits installed by this effort, and known future requirements, along with 50 percent of this total for spares.

a. Ducts between the cable vault and the first MH must be based upon the size of the switch, the number of outside cable pairs served from the switch location, the FO requirements, and future growth.

b. A main duct run includes the MHs and ducts from a DCO or node and provides the pathways for large feeder cables and/or core FOCs. New main duct runs must consist of a minimum of 6-way, 4-inch duct banks. In Europe, at least 125-mm ducts must be used. One of the ducts must be equipped with four integrated 30-mm (1.19-inch) (minimum) sub-ducts or four 51-mm (2-inch) conduits connected into an assembly.

c. A lateral duct run is defined as a minor branch run from the main duct run between MHs. New lateral duct runs must be a minimum of four-way, 4-inch duct banks. In Europe, at least 125-mm ducts must be used. One of the ducts must be equipped with four integrated 30-mm (1.19-inch) (minimum) sub-ducts or four 51-mm (2-inch) conduits connected into an assembly.

d. Entrance ducts are defined as ducts from a MH or hand hole to an EUB. New EUB entrance ducts must be a minimum of two-way, 4-inch duct banks. In Europe, at least 125-mm ducts must be used. One of the ducts must be equipped with four integrated 30-mm (1.19-inch) (minimum) sub-ducts or four 51-mm (2-inch) conduits connected into an assembly.

e. Entrance conduits in minor buildings, as listed in the design package, must be a minimum of one-way, 4 inch (100-mm) ducts if the entrance cables are less than 1-inch (25-mm) diameter and if less than 40 percent of the duct area must be used.

f. The lengths of ducts entering buildings or terminating at riser poles must not be placed longer than the values specified in Table 2 without prior U.S. Government approval.

g. In accordance with the NEC, cables entering a building from the outside and not rated for inside plant use may not extend beyond 50 feet (15 m) from the cable's point of entry into the building. The point of entry is defined as the place where the cable penetrates the exterior wall or floor. The point of entry may be extended beyond the 50-feet (15-m) limitation by using either rigid metal conduit (RMC) or IMC, both of which must be grounded. The EMT is not an acceptable media for extending the point of entry into a building. Reference the NEC, Sections 770.50 and 800.50.

### 3.8.4.6 Duct Installation Guidelines.

a. Depth of Cover – At least 24 inches (600 mm) of cover is required above the top of the duct bank. At least 18 inches (457 mm) of cover is required under roads or sidewalks (if duct is concrete-encased). For ducts installed in solid rock, the cover must consist of at least 150 mm (6 inches) of concrete. If rock is encountered below grade, the minimum cover above the concrete-encased duct must be 12 inches (300 mm). See Figure C-3 (Figure C-10 for Europe) – Conduit Placement/Cut and Resurface for details. The cover or fill must be compacted IAW UFGS-02300, Earthwork.

b. Trench Width – The installer must engineer the trench width to the minimum width required to support the size of the duct bank being installed. For installing ducts, the trench width depends on the number of ducts, size of ducts, arrangement of ducts, and space around ducts (at least 2 inches [50 mm]). Additional width may be required to work in deep trenches or with large count duct banks. Shoring of walls or sloping must be performed as required by the OSHA and/or local requirements. The trench width for DB conduit must be wide enough to permit tamping of dirt on the sides of the conduit formation. See Figure C-3 (Figure C-10 for Europe) – Conduit Placement/Cut and Resurface for details.

c. Concrete Encasement – The duct system must be concrete-encased in all main cantonment areas. At a minimum, the duct system must be encased under all traffic areas, where any bend/sweep exceeds 10 degrees, in any direction, and in any stream/drainage area subject to washing out. Concrete-encased duct, galvanized RSC, or pipe casings must also be placed under all paved road surfaces and certain heavy traffic non-surfaced roads as documented in the design package. The encasement/pipe must be extended a minimum of 6-feet (1.8-m) beyond the roadbed for all road crossings. The installer must use only one brand of Portland cement that conforms to American Society for Testing and Materials (ASTM) C 150. The concrete must be a wet type mix and placed in such a manner as to ensure the concrete completely surrounds all ducts and that no air or voids are trapped in the mix. (A dry bag of ready mix type cement that has not been mixed with water and just dumped in the trench is not acceptable.) The installer must obtain the signature of the on-site U.S. Government QC/QA representative, signifying the acceptability of the duct placement and spacing, prior to pouring any concrete over the duct. Concrete used to encase conduits must be a minimum 2,500 lb/in$^2$ (17,220 kPa) compressive strength.

d. Duct Placement – New ducts must be swept down and installed in the lowest available duct positions within the lowest available duct window in the MH. Additional ducts required in the future must be placed on top of the existing ducts. Ducts placed under this project must not prevent placement of future ducts in the upper duct positions. Conduits must terminate in bell ends or duct terminators at the point of entrance into the MHs and buildings.

e. Rerouting of Existing Ducts – Existing ducts must be joined to new MHs (pre-cast or cast-in-place) by rerouting the designated ducts from the demolished or abandoned MH to the new MH. Rerouting must begin far enough back from the old MH, at least 30 feet, to allow for standard bending radius and pulling tension. Continuity of operations on the affected cables must be maintained during the duct rerouting actions.

f. Reinforcement of Existing Ducts – New ducts installed to reinforce an existing duct bank must be placed above the existing duct bank, if the minimum top cover of 600 mm (24 inches) can be maintained. If sufficient top cover is not available, the new duct must be placed beside the existing duct bank.

g. Pull String/Rope/Tape – Once ducts are mandrelled to verify their integrity, a pull string, pull rope, or pull tape rated at not less that 200-lb (890-newton (N)) tensile strength must be installed in each new conduit and innerduct/sub-duct. A minimum of 5 feet (1.5 m) must be provided at each end of the conduit. The string/rope/tape must be coiled and secured at each end in such a manner as to prevent it from being accidentally pulled back into the duct.

h. Plugs – All ducts, sub-ducts, and, innerducts, whether main or subsidiary runs, must be plugged using universal duct plugs in MHs, hand holes, and building entrances. Foam sealant is not acceptable in a building.

i. Duct Seals – The area between the entrance conduits and the penetrated floors and/or walls of a building or MH must be sealed to be waterproof or fire-stopped as appropriate. Use of hydraulic cement between the duct and wall is acceptable for waterproofing the duct entry point.

j. Toneable duct – One duct in a new duct bank, containing only FOC, must contain an imbedded toneable metallic wire, or contain an installed toneable metallic wire for duct locates.

### 3.8.5 Galvanized RSC and Steel Casings.

For road crossings not using the cut and restore method, RSC or steel pipe casings must be used as specified in the design package. The RSC and steel casings must be placed under the highway in a manner that does not damage the conduit or casing.

#### 3.8.5.1 Size and Fill.

The installer must use a steel casing, a minimum of 12-inch (300-mm) diameter with a minimum wall thickness of 3/16-inches (5-mm), for pushing under commercial railroad crossings and for multi-duct conduit runs under non-commercial railroad beds. The steel casing must have an inner diameter, a minimum of 4-inches (100-mm) wider than the outer diameter of the conduit formation (with spacers) that is to be placed within the casing. Spacers will be used to support ducts installed within the casing. A single 4-inch (100-mm) diameter RSC can be installed under non-commercial railroad beds in single conduit applications. After the duct installation, the casing must be filled with fine sand (blown in with air pressure) or slurry and sealed on both ends with at least a 3-inch (75-mm) thick concrete wall. Installation of the fill will be done in such a manner so as to not damage or deform the ducts. See Figure C-3 (Figure C-10 for Europe) – Conduit Placement/Cut and Restore for details on railroad crossings.

#### 3.8.5.2 Materials.

Galvanized RSC used as telecommunications conduit must be made from soft, weldable quality steel that is suitable for bending. The hot-dipped zinc coating (galvanization) placed on the interior of the conduit must be smooth and free from blisters, projections, and other defects. The weight of the zinc coating on the interior and exterior surfaces should not be less than 2 ounces per square foot ($ft^2$) (61 grams per 1,000 square centimeters [$cm^2$]) of total coated surface. Steel pipe casings must comply with ASTM A-139 Grade B or ASTM A-252. Pipe ramming must be done IAW the USAISEC Technology Integration Center (TIC) Technical Report (TR) No. 2001.04.

### 3.8.6 Split Duct.

Split ducts are designed to be placed around existing cable, such as when repairing conduit, capturing existing conduit, or for use on a long DB cable run where the cable is placed in the open duct while the duct and trench are still open. Split duct must be used for crossing roads in DB cable runs only after one-fifth of the cable reel length for cables greater than 1 inch (25 mm) in diameter, and one-third of the cable reel length for cables less than 1 inch (25 mm) in diameter, is used in each unspliced span. The split duct under road crossings must be concrete-encased. Normal conduit must be used in all other areas.

### 3.8.7 Rod/Mandrel/Slug/Clean Ducts or Conduits.

#### 3.8.7.1 Rod Duct

Rodding a duct entails inserting or pushing a rod into the duct to:

- Determine the length of the duct
- Locate the other end of the duct
- Determine if the duct is usable or blocked
- Insert a pull string in the duct

#### 3.8.7.2 Mandrelling.

Mandrelling a duct consists of pulling a test mandrel or slug through the duct to ensure that the duct diameter is intact and ready for the installation of cables. Mandrelling can also be used to clean any mud, sand, or dirt out of the duct. The mandrel's diameter, 1/2-inch (13-mm) less than the duct's inside diameter, depends on the type and size of the ducts. New ducts in main and subsidiary duct runs must be mandrelled with a test mandrel (non-flexible) or slug that is approximately 12 inches (300 mm) in length and 1/2 inch (13 mm) less than the duct inside diameter. The test mandrel must be used to verify the integrity of the duct joints, to test for out-of-round duct, and to verify that sweeps are not so severe as to preclude the placement of large diameter cables. The 12-inch (300-mm) test mandrel must not pass through ducts with 90-degree sweeps. A 6-inch (150-mm) length test mandrel may be used to test duct runs to buildings or riser poles. Flexible mandrels, wire brushes, rubber duct swabs, leather washer duct cleaners, etc., may be used to clean the ducts.

#### 3.8.7.3 Existing Ducts.

Existing vacant ducts that are to be used in new cable installations, as defined in the design package, must be cleaned and tested with a test mandrel to detect any obstructions, collapsed ducts, or duct inconsistencies. The installer must repair damaged ducts if approved by the U.S. Government. The duct should not be mandrelled if existing cables are in the duct.

### 3.8.8 Sub-duct/Innerduct/Multi-duct/ Fabric Mesh Innerduct.

Innerduct, sub-duct, multi-duct, or fabric mesh innerduct is typically a nonmetallic pathway and may be placed within or in place of a duct to subdivide the space and facilitate initial and subsequent placement of multiple cables in a single duct space. All subdivided spaces must have a pull rope or pull tape installed. The PVC sub-ducts that do not have cables installed must be plugged with a duct plug. A minimum of one out of every four new ducts must be subdivided with innerduct, sub-duct, multi-duct, or fabric-mesh innerduct.

### 3.8.9 Sub-duct.

Sub-duct must provide the equivalent of four each 1-1/4-inch (32-mm) diameter (minimum) conduits in the space that is normally occupied by a 4-inch (100-mm) conduit. The sub-ducts must be held in relation to each other with spacers.

#### 3.8.9.1 Multi-duct.

Multi-ducts are pre-manufactured duct systems that are equipped with four fully integrated 1.19-inch (30-mm) (minimum) sub-ducts.

#### 3.8.9.2 Innerduct.

Innerducts are smaller diameter ducts, typically 1-inch (25-mm) diameter (minimum), that are placed inside existing ducts. The innerduct must consist of a minimum of three each, 1-inch (25-mm) PE ducts installed inside a single, 4-inch (100-mm) duct. Innerducts must be used in existing conduit systems, in RSCs, or in split RSCs. Rigid-type innerducts with pull strings must be provided.

#### 3.8.9.3 Fabric-Mesh Innerduct.

Fabric-mesh innerducts are made of a stiff, fabric mesh cloth folded and sewn in such a way as to create individual cells through which a cable may be installed without tangling with cables in other cells. Fabric mesh-type innerducts may be used as approved by the U.S. Government and must be limited to a maximum of six cells per tape, unless otherwise approved by the U.S. Government. The designer may specify up to three, three cell, tapes per conduit. Multi-cell fabric mesh will have an uninterrupted, shared, sewn spine to prevent twisting. Conduit formations must not be undersized based on the increased modularity of the fabric-mesh innerduct. Fiber optic cables must not be "home run" from buildings to serving nodes because of the increased modularity of fabric type innerducts. Fabric-mesh innerducts is available with tracer wire which would eliminate the need to install locator wire in conduit banks that are either empty or only contain dielectric cables.

#### 3.8.9.4 Conduit Rehabilitation.

The designer may consider rehabilitation of existing conduits as an alternative to installation of new concrete encased conduit where the cost, location, or magnitude of the construction effort is prohibitive. The conduit rehabilitation must be one IAW standard practices of ASTM 1216, using ASTM compliant products and processes. The rehabilitated conduit should have an inner diameter sufficient to support the intended cable installation and minimal growth. The designer should note that the inner diameter of existing conduits will be reduced by the application of resin-impregnated tubes for rehabilitation.

#### 3.8.9.5 Rehabilitation Survey Requirements.

Conduits intended as candidates must be inspected to ensure that rehabilitation is feasible. The ASTM 1216 states that conduits must be cleaned and inspected prior to the installation of the resin-impregnated tube. Therefore, the survey must verify that cleaning is sufficient to prepare the conduit for rehabilitation. The survey should include inspection from manhole or building entrance end points, either visually or by a conduit video system of both ends of the conduit. A record of the video inspection should be maintained after the survey. Collapsed or crushed duct should not be used for rehabilitation.

#### 3.8.9.6 Rehabilitation QA Inspection and Acceptance.

Restored conduits should have a friction coefficient that meets ASTM 1216. The conduit should be inspected by a conduit video system to verify it was restored to a usable system that meets the minimum requirements outlined in the underground conduits section of this guide, with the exception of inside diameter.

### 3.8.10 Directional Boring/Horizontal Directional Drilling (HDD).

The HDD is a trenchless method for installing ducts for underground cable. Ducts are installed by drilling or boring a path through the soil and placing the ducts within this path. The vertical profile of the bore alignment is typically in the shape of an inverted arc.

#### 3.8.10.1 Restrictions.

Ducts installed using the HDD method under roads must be deep enough to clear existing utilities and meet H-20 load ratings. The ducts placed by HDD must not directly enter a MH but must be attached to conduit stub-outs that extend a minimum of 10 feet (3 m) from the MH. The HDD may be done in areas approved by the U.S. Government or as stated in the design package. The maximum radius curvature of a bore is limited to the maximum conduit diameter times 100 feet per inch (30.5 m per 25 mm).

#### 3.8.10.2 Methodology.

The HDD is a multi-stage process consisting of drilling a pilot bore along a predetermined path and then pulling the desired product back through the drilled space. Utilize back reaming when it is necessary to enlarge the pilot bore hole. In order to minimize friction and provide a soil-stabilizing agent, a drilling fluid is introduced into the annular space created during the boring operation. The rotation of the bit in the soil wetted by the drilling fluid creates slurry. This slurry acts to stabilize the surrounding soil and prevents collapse of the borehole and loss of lubrication.

#### 3.8.10.3 Pits.

In order to confine any free flowing slurry at the ground surface during pull back or drilling, sump areas must be created to contain any escaping slurry that might damage or be hazardous in surrounding areas. All residual slurry must be removed from the surface and the site restored to preconstruction conditions. Excavation for entry, recovery pits, slurry sump pits, or any other excavation must be carried out as specified in UFGS-02300 Earthwork. Sump areas are required to contain drilling fluids.

#### 3.8.10.4 Drilling Fluids.

A mixture of bentonite clay or other approved slurry and potable water must be used as the cutting and soil stabilization fluid. The viscosity must vary to best fit the soil conditions encountered. Water used must be clean and fresh, with a minimum of a 6-Phosphate (pH) level. No other chemicals or polymer surfactant (surface-active substance) are to be used in the drilling fluid without the written consent of the U.S. Government and after a determination is made that the chemicals to be added are environmentally safe and not harmful or corrosive to the facility. When drilling in suspected contaminated ground, the drilling fluid must be tested for contamination and disposed of appropriately. Any excess material must be removed upon the completion of the bore.

#### 3.8.10.5 Tracking.

The installer must provide a method of locating and tracking the drill head during the pilot bore and must ensure the proposed installation is installed as intended. All facilities must be installed in such a way that their location can be readily determined by electronic designation after installation. For non-conductive installations, this must be accomplished by attaching a continuous conductive material externally, internally, or integrally with the product. A copper wire line or a coated conductive tape may be used for this conductive material.

#### 3.8.10.6 Duct Installed by Directional Boring.

Materials must meet or exceed the following standards:

| Material Type | Standard |
|---|---|
| PE | ASTM D 2447 |
| HDPE | ASTM D 2447 |
| | ASTM D 3350 |
| | ASTM D 2239 |

A PVC conduit with mechanical connectors made for the purpose of directional drilling may be used with U.S. Government approval.

#### 3.8.10.7 Joints.

An HDD conduit must be placed with soil tight joints. Joints between dissimilar types of ducts (PVC, HDPE, GSP, EB, DB, etc.) must use the appropriate connectors to provide a seal between the ducts and to prevent damage to cables pulled through these joints.

#### 3.8.10.8 Restoration.

The site must be restored after installation of the conduit is complete. The work site must be cleaned of all excess slurry remaining on the ground. The installer performing the boring is responsible for removal and final disposition of excess slurry or spoils as the conduit is introduced. Excavated areas must be restored IAW UFGS-02300, Earthwork. The cost of restoring damage caused by heaving, settlement, escaping drilling fluid (fracout), or the directional drilling operation to roads, parking lots, pavements, curbs, sidewalks, driveways, lawns, storm drains, landscapes, and other facilities must be borne by the installer. Fracout is the case of environmental damage, when the bentonite clay used, instead of reaching its intended destination, seeps into the waterways or into the ground, ruining the habitat.

### 3.9 Direct Buried Cable Installation.

The DB cable must be engineered and installed IAW RUS Bulletins 1751F-640, 641, and 642.

#### 3.9.1 Cable Type.

Rodent-protected cable must be used for all buried applications, unless otherwise specified in the design package.

#### 3.9.2 Warning Tape.

See paragraph 3.6.10 for the details on warning tape.

#### 3.9.3 Warning Signs.

Buried cable warning signs or route markers must be provided no less than every 250 feet (76 m) or at each change in route direction, on both sides of street crossings, on pipelines, and on buried power cables. Color-coded warning signs or markers must be orange in color.

#### 3.9.4 Plowing.

Plowing must be used in range environments or other areas where there are no significant obstacles and where cable runs typically exceed 1,000 feet (305 m) between splices. The design package must identify areas in which plowing is deemed feasible.

#### 3.9.5 Trenching.

##### 3.9.5.1 Backhoe Trenching.

Trenching with a backhoe must be done only for short distances (i.e., MH to building). The installer must hand dig at all existing MH locations, building entrance points, utility crossings, through tree roots, under curbs, etc.

##### 3.9.5.2 Trencher Trenching.

A maximum trench width of 12 inches (300 mm) must be used in DB applications done by a trencher. The installer must hand dig at all existing MH locations, building entrance points, utility crossings, through tree roots, under curbs, etc.

#### 3.9.6 Depth of Placement.

##### 3.9.6.1 Copper Cable.

The depth of placement for a DB copper cable must provide a minimum top cover of 24 inches (600 mm) in soil, 36 inches (900 mm) at ditch crossings, and 6 inches (150 mm) in solid rock (RUS Bulletin 345-150/RUS Form 515A).

##### 3.9.6.2 FOC.

Direct buried FOC must be placed at a depth providing a minimum top cover of 42 inches (1070 mm). In solid rock, the minimum top cover must be 6 inches (150 mm).

##### 3.9.6.3 Frost Considerations

In areas where frost heaving can be expected, the cable or wire should be buried below the frost line. Movement of OSP housings due to frost heaving can cause damage to the insulated copper conductors, optical fibers, or loss of shield and/or armor continuity. In areas where movement of OSP housings by frost heaving is encountered, the OSP housings should be installed on stub poles. The stub poles should be set below the frost line and IAW the requirements of RUS Form 515.

#### 3.9.6.4 Other Considerations

The DOIM/DPW may have special depth requirements for certain areas (i.e., tank tracks, ranges, etc.), which must be provided in the design package.

### 3.9.7 DB Cable Splicing.

Buried splices must be engineered and installed as identified in the design package. For example, a buried splice may be used for the following conditions with U.S. Government approval:

- Electrical or explosion hazard (i.e., ammunition areas)
- Vehicular hazard (i.e., motor pool areas)
- Security hazard (i.e., within a high security compound)

Only splice cases specifically designed for a buried application must be used. All buried splices must be encapsulated. All other splices in a DB run must be placed in pedestals or MHs. Encapsulation is not required in a pedestal.

## 3.10 Crossing Obstructions.

### 3.10.1 Pavement Crossing.

Cut and resurface is the preferred method to be used when crossing any paved area. Push/bore and/or directional boring must be used for special circumstances only as specified in the design package. The preferred method of cut and resurface is the “T” cut. That is, the outer edge of the cut of the road surface is to extend six inches beyond the edge of the trench on both sides. See Figure C-3 (Figure C-10 for Europe) – Conduit Placement/Cut and Resurface for placement details.

### 3.10.2 Range Road Crossing.

For road crossings on ranges, concrete encasement must be extended a minimum of 6 feet beyond the edges of the roadbed.

### 3.10.3 Railroad Crossing.

Push and bore with steel casings is the preferred method for railroad crossings. When multiple conduit formations are placed, a minimum of a 12-inch (300-mm) diameter steel casing, with a minimum wall thickness of 3/16-inch (5-mm), must be used. The casing must extend no less than 12 feet (3.7 m) beyond the centerline of the track or the outermost track if multiple tracks are crossed. In accordance with the NESC, the casing must be located no less than 50 in (1,270 mm) below the top of the rails. The casing should be no less than 36 in (900 mm) below the bottom of any crossed drainage ditch.

Directional boring must not be used to place conduits below commercial railroad beds. Directional boring is not the preferred method to place conduits below U.S. Government railroad beds. When required by the U.S. Government, as stated in the design package, directionally bored HDPE must be placed a minimum of 15 feet (4.6 m) below the roadbed in typical soil. The conduits must be placed at a depth so that standard E-80 live and impact loads 80,000-lb/ft (119,500-kg/m), axle loads spaced on 5-feet (1.5-m) centers) must not produce more than five percent deflection in the proposed HDPE conduits.

### 3.10.4 Rocky Soil Crossing.

Pushes must not be engineered for sites with rocky soil conditions. Boring must not be engineered for sites with rocky soil conditions without U.S. Government approval. Cut and resurface methods must be used to the maximum extent possible.

## 3.11 Aerial Cable.

Supporting documentation for aerial placement is available in RUS Bulletins 1751F-630 and 1751F-635. Aerial cable runs must be used only with U.S. Government approval in extenuating circumstances or for long runs outside of the cantonment area, as specified in the design package.

### 3.11.1 Messenger Strand.

The smallest messenger strand used for all new installations must be 6.6 m. A 2.2-m strand must be used only as an extension of existing 2.2-m strands. Fiber optic cable must be installed on its own messenger. Copper and fiber cables must not be lashed on the same messenger without U.S. Government approval. Figure 8 cable may be used; however, no additional cable must be lashed to it.

### 3.11.2 Guys and Anchors.

Place new guys and/or anchors for each new messenger strand at each applicable location (cable turns, wind loading, cable ends, etc.). The down guy must be sized to the next larger strand.

### 3.11.3 Aerial Splices and Terminals.

#### 3.11.3.1 Fiber.

Aerial fiber splices must not be used without U.S. Government approval. Fiber optic splices must be placed in a pedestal at the bottom of the pole.

#### 3.11.3.2 Copper.

Support all terminals and splices by direct attachment to a fixed object (pole, building, pedestal, etc.). The cable must not support devices. Pole-mounted and fixed-count terminals must be used. Terminals must be placed so that no single drop exceeds 152 m (500 feet) in length.

### 3.11.4 Water Protection.

Weatherproof all outdoor connections by using weather boots or other approved methods. Form a rain-drip loop at all cable entrances into buildings at the point of ingress. Waterproof all building entrance points.

### 3.11.5 Horizontal Clearances for Poles/Aerial Cable.

The following horizontal clearances, as specified in the *AT&T Outside Plant Engineering Handbook*, Practice 918-117-090, must be adhered to, unless otherwise directed by the design package:

- Fire hydrants, signal pedestals – 4 feet (1.2 m)
- Curbs – 6 inches (150 mm)
- Railroad tracks – 15 feet (4.6 m)
- Power cables less than 750 volts (v) – 5 feet (1.5 m) or more

### 3.11.6 Vertical Clearances for Aerial Cable.

The following vertical clearances, as specified in the *AT&T Outside Plant Engineering Handbook*, Practices 627-070-015 through 017, and Practice 918-117-090, must be adhered to, unless otherwise directed by the design package:

- Streets or roads – 18 feet (5.5 m)
- Driveways to residences and garages – 10 feet (3 m)
- Alleyways – 5.2 m (17 feet)
- Pedestrian walkways – 8 feet (2.4 m)
- Railroad tracks (measured from top of rail) – 27 feet (8.2 m)

### 3.11.7 Cable Placement on Bridges and Over Waterways.

The designer should specify attachments to bridges so they will not interfere with painting of the bridge structures. The designer should also follow these recommendations:

a. The designer should ensure that the lowest cable point is far enough above the high water mark to avoid being entangled in flotsam when making attachments over waterways which are subject to flooding.

b. The designer should, use a messenger strand, when placing aerial cable on bridges, and lash the cable to it to prevent abrasion to the cable sheath. The use of cable rings is not recommended due to abrasion concerns.

c. The designer should specify that the bell end of the conduit is installed in the direction from which the cable is pulled to prevent pull line or cable snags on a non belled end, when placing conduit for cable installation on a bridge,.

d. The designer should specify expansion joints at locations where the bridge expansion joints exist to prevent cable stretching and to facilitate all bridge members (the cable now being one) flexing at the points designated. Provision for expansion must be made if the bridge has such provision.

e. The designer should specify inner duct in the conduit for installation of small cable, allowing for future expansion. Inner duct either corrugated or fabric mesh does not of itself require expansion joints; however, particular attention must be paid in letting the inner duct "relax" or contract back to its original size and length after the pull is complete.

### 3.12 Free Space Optics.

The FSO can provide an alternative to FO connectivity, for the "last mile," to EUBs and small enclaves. Typical FSO implementations arise from one of the following factors that prohibit traditional infrastructure– rapid deployment, right of way permit issues, water, railroads, and rough terrain. The FSO is a line-of-sight (LOS), point-to-point, wireless optic technology that uses the transmission of modulated infrared beams through the atmosphere to obtain broadband communications. The FSO operates in the unlicensed near-infrared spectrum 750 nanometer (nm) to 1550 nm wavelength range. The FSO systems can function over distances of several kilometers (km), as long as there is a clear LOS between the source and the destination.

Design Note: For systems operating at 1.25 gigabits per second (Gbps) the link distance should be kept around 1000 meters. If the FSO system is to operate in an environment of low visibility (fog) a back up system (e.g., MMW, SHDSL, 802.11a) should be used.

There are a number of manufacturers producing FSO equipment. The designer should utilize an FSO device that was tested, approved, and recommended by the USAISEC TIC. The FSO equipment must be designed to prevent data loss due to temporary blockages, such as birds, smoke, dust, rain, and light fog. The FSO devices must be FDA and IEC 60825-1 Class 1M approved to ensure safety. Operational test reports on individual equipment are available from USAISEC TIC, such as TR No. AMSEL-IE-TI 04-009 November 2003 *Free Space Optics (FSO) Comparison Report* and TR No. AMSEL-IE-TI, 05-066, June 2005 *Grafenwoehr Free Space Optics (FSO) Demonstration Report.*

### 3.12.1 FSO Technical Requirements.

The FSO will meet or exceed the following requirements:

a. Comply to or exceed industry standard emissions and eye safe considerations (e.g., certified eye safe as per IEC 60825 Class 1 or Class 1M)

b. Support Simple Network Management Protocol management

c. Support remote configuration and management

d. Remote diagnostics capabilities

e. Environmental controls (heater, defrosters, etc.)

f. Automated acquisition of link capabilities

g. Management channel

h. Support for GbE

i. The equipment must be constructed so as to have sufficient protection against dust, sand, or birds. Hardened housing must be used to provide robust, waterproof environment.

j. The system must maintain its guaranteed performance when operates continuously or intermittently under any combination of the following conditions without readjustment and when maintained IAW the vendor’s recommendation:

k. Ambient temperature: 10º Celsius (C) to 40ºC (indoor) 10ºC to 50ºC (outdoor)

l. Relative humidity of up to 95 percent.

m. The system must be fully protected against lightning and voltage surge. It must also be protected against damages from accidental reversal of polarity.

n. All test equipment, tools, accessories, and software necessary for the Operation and Maintenance support must be submitted as part of the FSO System offer.

### 3.12.2 FSO Considerations.

The designer must consider a number of different factors when deploying FSO. These include installation stability, beam alignment, mounting locations, atmospheric effects, impairments, required throughput, signal interfaces, security requirements, power requirements, and power availability.

#### 3.12.2.1 Installation Stability and Beam Alignment.

The FSO equipment is typically mounted on the outside edge of building rooftops, on towers or inside building windows. These “solid” objects tilt, twist, vibrate, and sway due to heat, wind load, and seasonal changes. The FSO equipment used should be able to compensate for minor movements and maintain beam alignment. There are generally two methods for keeping FSO laser transmitters and photo detection receivers aligned: active beam tracking and beam divergence. Active beam tracking allows the FSO system to adjust end-to-end alignment a small number of degrees through beam strength tracking. Beam divergence is the intentional spreading of the laser beam to allow for FSO link head movement within both receivers' field of view.

#### 3.12.2.2 Mounting Locations, Atmospheric Effects, and Impairments.

The FSO transmitters and receivers should be mounted as close to the building edge as possible. Setting the transmitters or receivers back could cause beam interference due to heat scintillation or refraction from the building roof. When placed within a building, FSO can work through building windows with little or no attenuation. This allows the designer to avoid roof rights or premise cabling pathway issues. The designer should consider actual glass losses in the overall link budget for through window implementations. Additionally, the designer should investigate to see if newer windows are manufactured with an infrared reflecting coating or if older windows have a high lead content. The Infrared (IR) coating or lead could add severe impairment to a FSO link.

The designer must consider the occurrence of rain, dust, snow, fog, or smog when implementing FSO. These weather conditions can add impairments to the transmission path. USAISEC TIC testing has shown fog to cause severe and sometimes total signal loss. Signal penetration through prevailing weather conditions is a factor of beam strength, distance, and weather interference. The FSO device should have gain control to accommodate distances and weather conditions. The gain control may be manual or automatic. However, beam power output is restricted by the eye safety requirements for this class of LASER. The designer should consider a radio backup link) for severe weather conditions, such as most millimeter-wave, microwave, 802.11 Wireless LAN (WLAN), or 802.16 WiMAX. The FSO laser does not need municipal or host nation approval, but the backup radio link may require approval and frequency management. The backup wireless link may have additional security requirements as the radio frequency (RF) signal can not be controlled as well as the FSO beam.

#### 3.12.2.3 FSO Security.

DOD Directive (DODD) 8100.bb requires Federal Information Processing Standard (FIPS) 140.2 Level 1 or 2, end-to-end encryption, on all Army wireless implementations. Therefore the designer must incorporate required encryption of data passed through the FSO required to pass FIPS 140-2 and IA certification. The designer should ensure that any encryption hardware is cable of supporting the throughout speeds and protocols.

#### 3.12.2.4 FSO Throughput.

The FSO throughput is a factor of beam strength, distance between devices, and weather conditions. The designer must consider the required bandwidth against the specific distance for each application. For systems operating at 1.25 Gbps the link distance should be kept around 1000 meters.

#### 3.12.2.5 FSO Signal Interfaces.

The FSO device should be able to interface to the local data switch through standard FO connectors such as SC type connectors. The FSO device should be able to transparently transport the data stream.

## 3.13 General Range Information Infrastructure Design.

The telecommunications sections of range construction projects must follow the general provisions of the U.S. Army I3A TG for new construction and renovations. There are several distinct types of information networks in a range environment: administrative, range control (RC), and tactical. The administrative networks support telephone and data requirements to the occupants of the range buildings, and safety telephones. The special RC networks control down-range targets, sensors, and monitors and transports this information to off-site locations. The tactical networks support the unit training requirements in a field environment. In addition, there could be security and alarm networks.

These paragraphs provide guidance for the design of the administrative use networks with provisions for interfacing with the other networks. The following paragraphs provided specific design information for TRs and OSP telecommunication cables for range projects.

### 3.13.1 TRs.

In multi-story buildings, a minimum of one TR must be located on each floor, with one TR acting as the aggregating TR or main cross-connect (MC) for the building. Small facilities (i.e., air traffic control towers, firing range towers, etc.) may use one TR for the entire facility. The TRs on successive floors must be vertically stacked, wherever possible. A minimum of four, 4-in trade size conduits must be installed between stacked closets on successive floors, IAW ANSI/EIA/TIA-569-B, paragraph 8.12.

### 3.13.2 Backbone Cabling.

The backbone cabling for range facilities must be single mode FO IAW the I3A TG. The IT designer must also refer to the I3A guide for supporting infrastructure for the distribution and riser cables.

### 3.13.3 Range Information Infrastructure Design.

Utilizing the RC building as a distribution node for all range telecommunications and as an intermediary between the ranges and the main cantonment area provides the ideal range information infrastructure architecture. The DB cable plant must be used for range telecommunications cables. If it is not feasible to use DB cable due to local mandates or rough terrain, aerial cable plant may be used. Pedestals or MHs must be placed at end of reel splice locations, where access to cable pairs or strands is required, and at future use points. In some range scenarios, a MH or a buried splice would be preferred over a pedestal due to the free roaming abilities of heavy equipment, such as tanks and mowers. When using pedestals, efforts must be taken to protect it from damage, such as protective stub poles, locations in tree lines, or close-to-steep banks. When using buried splices, above ground warning signs and electronic locating devices, such as radio frequency ID or magnetic devices, must be located with the splice.

#### 3.13.3.1 Maintenance Hole and Duct Systems.

The IT designer must normally not use the MH and duct systems architecture in the range environment. Maintenance holes and ducts would incur too high a cost to the range project. At individual range complexes, a MH and duct infrastructure could be installed from RC building to adjacent support buildings for growth and expansion. When a duct system is required, a minimum of two, 4-in PVC ducts, one with four sub-ducts or nine-way (3 each 3-way) textile mesh, must be installed to each individual support building.

#### 3.13.3.2 Direct Bury Depth of Placement.

The minimum depth of placement for a DB copper cable to ranges must provide cover of 36 in of soil; 48 inches at ditch crossings, and 6 inches of solid rock. To direct bury a FOC, the minimum depth must provide a cover of 42 inches overall. In solid rock, the minimum depth is reduced to 6 inches for FOC. The DOIM may have special depth requirements for certain areas, such as tank trails, firing ranges, etc.

#### 3.13.3.3 Concrete Encasement.

The IT designer must normally not use a concrete-encased underground MH or duct systems in the range environment. Maintenance holes and ducts would incur too high a cost to the range project. Concrete encasement or GSP must be used in range projects under road crossings, heavy equipment (tank) crossing, or high traffic areas. The IT designer must plan for four, 4-inch PVC ducts; one with four sub-ducts or nine way (3 each 3-way) textile innerducts, under road crossings, heavy equipment (tank) crossings, and high traffic areas. The encasement/pipe must be extended a minimum of 6 feet beyond the roadbed for all road crossings, heavy equipment (tank) crossings, and high traffic areas on ranges. IAW the referenced standards, PVC ducts must also be encased in concrete at all sweeps or bends; at stream or drainage ditch crossings, or other areas subject to washout. For consistency, the contractor must use only one brand of cement that conforms to RUS Bulletin 1751F-644 (http://www.usda.gov/rus/telecom/publications/pdf_files/1751f644-08-02.pdf).

### 3.13.4 OSP Cable.

The IT designer must consider DB cables as the first choice for range telecommunications cables. If it is not feasible to use DB cables due to local mandates or rough terrain, aerial cables shall be used. The IT designer must specify a minimum of 24 strands of single mode FOC from the DCO, or closest RSU, to RC building. Alternatives to FOC between the main cantonment area and the RC building may be considered on a case-by-case basis. The IT designer must also specify a minimum of 12 strands of single mode FOC from the RC building to the individual ranges or range buildings. The IT designer must use single mode FOC, as needed, to extend the data backbone, monitor circuits, sensors, cameras etc., to all range buildings from the RC building. Alternatives to FOC between the RC building and the individual ranges or range buildings may be considered on a case-by-case basis. In addition to the normal administratively required strands of FOCs for voice and data networks to the ranges, the range cables must be sized to support circuits for the ever-changing training and tactical scenarios, and RC (minimum 25-percent spare strands). Cables homed to the RC facility would add flexibility to these systems.

## 3.14 Pier Installation.

Pier telecommunications should be installed in a duct system, with pull boxes placed at critical points.

### 3.14.1 Pier Igloos.

Pier Igloos are structures where cable is terminated into terminal/plugs for shipboard use. Cable is generally run to igloos via a conduit system, raised into the igloos for termination and use, and is cross-connected to cable continuing to other igloos. Igloos can provide both copper and FO termination through a commercially available combination fiber/copper cable type plug for shipboard use. This connectivity provides service to meet shipboard requirements. Inside the igloo, restricted from shipboard personnel, FO and copper cross connections may be changed to meet special requirements for special situations. See Figure C-16 of Appendix C for igloo details.

### 3.14.2 General Pier Installation Guidance.

Expansion joints are required at each pier expansion joint and areas where the conduit enters an Igloo. The PVC covered GIP or fiberglass conduit should be used for the conduit and must be installed in such a manner that docking vessels cannot crush or scrape it. For that reason, the designer should place the cable on the underside of the pier and support with approved PVC covered (NFGS Specification, Section 16722A) or stainless steel hangers. The designer should place an inner duct into the conduit if only a small cable is to be installed. If spare ducting is to be placed, ensure that a pull line is installed and that the duct is plugged or capped at both ends of the run. If the spare duct enters or exits a pull box, plugging or capping is required inside the pull box. Expansion joints act like a slip joint, allowing the conduit to move, (breathe), precluding separation or buckling. If the conduit is to be allowed to move, the cable and inner duct must not be installed taut or it must break. Leave sufficient slack to allow for the conduit movement. Slack for expansion must also be left in pull boxes.

### 3.14.3 Pier Cable Types.

Copper and FO cables for shipboard use should be terminated in igloos located at the pier edge. These igloos may provide data, telephone, and video, (Cable TV, security cameras etc). All ship board connectivity is accomplished via the front faceplate of the igloo. Only station/base personnel should have access to the igloo internal cabling and only they should be permitted to make physical wire or cable changes. Only filled cables such as PE-39 and filled FOC should be installed on piers.

## 3.15 General Cable Specifications.

### 3.15.1 General Installation.

Cables must be placed in such a manner as to avoid kinks and other sheath deformities.

#### 3.15.1.1 Pulling Tension.

When pulling cable into ducts, innerducts, or sub-ducts, the manufacturer's specified pulling tension must not be exceeded. A lubricant must be used in the amount specified by the lubricant manufacturer. The lubricant must be a pourable, water-based, slow-drying fluid that must not stress-crack the low-density PE and must not damage the cable jackets.

#### 3.15.1.2 Evaluating Existing Cable/Testing New Cable.

When the installation includes work on an existing cable, the installer must test all affected pairs before completing any throws or splices. A list of the defective pairs must be submitted before the work proceeds. After the cable work is completed, the installer must test all affected cable pairs. The installer must clear trouble on any existing pairs that were not on the original list.

#### 3.15.1.3 Bending Radius.

During installation, the minimum bend radius for non-gopher resistant OSP twisted-pair cable must be no less than 10 times the cable diameter; after installation, it must be no less than eight times the cable diameter, or as specified by the cable manufacturer. The minimum bend radius for gopher-resistant OSP twisted-pair cable during installation must be no less than 15 times the cable diameter; after installation, it must be no less than 10 times the cable diameter, or as specified by the cable manufacturer (reference TIA/EIA 758, paragraph 6.1.4.4). The minimum bending radius for FOCs during installation must be no less than 20 times the outside diameter of the FOC, or as specified by the cable manufacturer, and after installation must be no less than 15 times the cable diameter (reference TIA/EIA 758, paragraph 6.3.6).

### 3.15.2 Cable ID/Cable Tags.

Cable tags must be installed at all termination points (terminals) and splices, including house cables. In MHs, all new and existing cables that are part of the project must be tagged/retagged between the splice and the wall and on both sides of a splice loop or maintenance loop. One tag is required for a copper cable pull-through, and two tags are required for a FOC pull-through.

a. To identify a copper cable, size + type **and** cable ID+ count are needed.

b. Cable sizes must be identified with an abbreviation. For example, a 1,200-pair cable must be identified as P12-24PF. All cables with fewer than 25 pairs must include an "X."

- 6-pair = P6X-24PF
- 12-pair = P12X-24PF
- 18-pair = P18X-24PF
- To identify a 900-pair, 24- AWG copper cable:
- P9-24PF = size and type
- 03, 1-900 = cable number and count
- (Only **existing** cable is identified with a "CA" prefix.)
- To identify two different cables under the same sheath:
- P18-24PF
- 07, 1-1,500 + T1, 1-300
- Fiber optic cables must be identified with cable ID + count **and then** size + type.
- F 12, 1-72 = cable number and strand count
- 12 SM = type of cable
- To identify a 10-pair, 0.6 mm European copper cable:
- 10x2x0.6 = size and type

- 01, 1-10 = cable number and count
- To identify an 800-pair, 0.6 mm European copper cable:
- 800x2x0.6 = size and type
- 05, 1-800 = cable number and count

### 3.15.3 Copper Specifications.

#### 3.15.3.1 Telephone Cable Requirements.

The installer must ensure that all cable used in North America is UL listed and meets the specifications of Telcordia Document, GR–421–CORE, *Generic Requirements for Metallic Telecommunications*, December 1998. Cables specified for use in Europe may not meet UL or Telcordia specifications.

#### 3.15.3.2 European Telephone Cable Requirements.

All multi-pair copper cable installed between buildings must be waterproof, IAW DIN VDE 0815 and 0816, *Wiring Cables for Telecommunications and Data Processing Systems.* The copper conductor size must be 0.6-mm diameter. Commercially available industry standard cables must be type A-02YSOF(L)2Y...x2x0.6 ST III BD (the "…" denotes the pair count).

a. The conductors in the cable must be color-coded. A basic color-coding scheme must be used to provide different color combinations on the insulation for each pair. The North American standard is based on a 25-pair group IAW Telcordia Documents (Tip: white, red, black, yellow, violet; Ring: blue, orange, green, brown, slate). The European standard is based on 10-pair groups as follows:

- The basic colors of wires of five starquads in the sub unit are red for the first quad, green for the second quad, grey for the third quad, yellow for the fourth quad, and white for the fifth quad
- Black rings code the individual wires
- The pilot unit bears a red helix
- All other units bear a white or transparent helix

b. Minimum Guaranteed Pairs: One hundred percent of pairs in a cable prior to installation and 99 percent of pairs after installation where it is not economical to recover the defective pair(s) must pass performance or acceptance tests. Defective pairs must be identified by location and type of fault. Splicing faults must be corrected.

#### 3.15.3.3 Splices.

a. Copper and FOC splicing must be performed IAW RUS Bulletin 1735F-401, *Standards for Splicing Copper and Fiber Optic Cable*, February 1995.

b. Cable must be spliced into one continuous length. All copper splices must be of the fold-back type to facilitate future work in the splice. Fiber cable must contain splice loops in trays IAW manufacturer's recommendations.

c. Completed splices must meet similar performance and mechanical specifications of a single cable of the same overall length.

d. Self-piercing electrical filled connectors must be used when splicing plastic-insulated conductors. The installer must place and install connectors using a tool specifically designed to place those connectors. In North America, a 25-pair splicing module, 3M-type MS2 or equal must be used. The same modules must be used throughout the project and must be consistent with previously installed connectors to preclude a requirement for a variety of installation tools. B-wire connectors must not be used. In Europe, a 10-pair splicing module system is used.

e. Binder group integrity must be maintained.

f. All dead pairs in a copper cable must be spliced through if the size of the continuing cable must allow a clear and cap at the end. Only UL listed material must be used when capping cable pairs.

g. All underground and buried splice cases must use encapsulant-fillable closures and must be filled with encapsulant upon completion of the splice IAW RUS Bulletin 345-72 (PE-74). Cable sheaths must be bonded at all cable splices with bonding harnesses to assure sheath continuity.

#### 3.15.3.4 Cable Count Assignment.

When assigning cable counts, the center of the cable must be the last pairs assigned on a cable route. The upper or higher cable pair counts must be used first. Therefore, the highest pair count in a cable must be located closest to the switch location, and the lowest pair count must be farthest away. Per the requirements of 6- and/or 12-pair terminals, pair 13 (of a binder group) rather than Pair 1 must be spared.

#### 3.15.3.5 Cable Gauge, Resistance Design.

The cable gauge must be 24-AWG (0.6 mm in Europe), unless otherwise specified in the design package.

#### 3.15.3.6 Loading.

a. Analog sets/circuits exceeding 18,000 feet (5.49 km) require U.S. Government approval. If approved, these sets/circuits must be loaded.

b. When loading cables, H88 loading must be used 3,000 feet (914 m) from the switch location/digital loop carrier for the first load (including calculations for tip cables, jumper wires, etc.) and every 6,000-sheath feet thereafter. End sections must be greater than 3,000 feet (914 m) and less than 12,000 feet (3.66 km). End sections include all drops and station wire.

c. Build-out capacitors must be designed on trunk circuits between switches for placement between load points for distances shorter than 6,000 feet (1.83 km) between loads or between loads and end sections.

d. Pairs for any data circuits must not be loaded.

e. If digital or data sets are being used for the telephone system, these pairs must not be loaded.

### 3.15.4 Fiber Specifications.

#### 3.15.4.1 FOC Requirements.

All specifications for FOCs pertain to finished cable, not raw (uncabled) fiber. The FOC must conform to the specifications contained in RUS Bulletin 1753F-601, EIA/TIA-472, and EIA 472D. See Table 1 for the complete names of these references.

### 3.15.4.2 Fiber Types.

All new OSP fiber cable must be single-mode. With U.S. Government approval, multimode fiber may be installed only in situations involving the extension of existing systems, as specified in the design package, or in situations that cannot be adapted to single-mode cable.

a. Multimode Fiber – Fiber strands must have a nominal core/cladding diameter of 50/125 or 62.5/125 microns. All cabled multimode fibers must possess the following characteristics over the entire specified temperature range as shown in Table 4.

**Table 4. Multimode Dual-windowed Fiber Cable Characteristics**

| Function | Parameters for 50 microns | Parameters for 62.5 microns |
|---|---|---|
| Core/Cladding Diameter | 50/125 | 62.5/125 |
| Coating Diameter Microns | 250 | 250 |
| Core Eccentricity Maximum | 6% | 6% |
| Core Ovality | 6% | 6% |
| Refractive Index Delta | 1% | 2% |
| Core Diameter Microns | 50 +/-3 | 62.5 +/-3 |
| Cladding Diameter Microns | 125 +/-3 | 125 +/-3 |
| Numerical Aperture | 0.20 +/-0.015 | 0.275+/-0.015 |
| 850 nm | | |
| Maximum Attenuation dB/km | 3.5 | 3.75 |
| Minimum Bandwidth MHz-km | *****500 | 160 |
| 1,300 nm | | |
| Maximum Attenuation dB/km | 1.5 | 1.0 |
| Minimum Bandwidth MHz-km | *****600 | 500 |
| Cable Tensile Load Rating | ******2,670 N (600 lb) | |
| Cable Minimum Bending Radius | 15 x cable diameter under no load. **0-800 N (0-180 lb). 20 x cable diameter under load. **800-2,700 N (181-600 lb) (Note 2). | |
| *****Building/Breakout Cables (Tight Buffer). Minimum bandwidths do not apply to tight buffered, or breakout-type cables. The minimum bandwidths for tight-buffered cable are 400 MHz-km at both 850 nm and 1,300 nm. The index of refraction profile of multimode fiber must be near-parabolic graded index. ******Building/Breakout Cables (Tight Buffer). Tensile load rating and minimum bending radius do not apply to tight-buffered breakout-type cables. | | |

dB=decibel; km=kilometer; MHz=megahertz; nm=nanometer

b. Single-mode Fiber – Fiber strands must have a nominal core diameter of 8.3 microns. The cladding diameter must be 125 microns (+/-2 microns). All cabled single-mode fibers must have a maximum attenuation value of 0.35 dB/km for high grade at 1,310 nm over the entire specified temperature range as shown in Table 5. The fibers described in Table 5 are glass with a protective coating and an outer buffer tube. These fibers are placed in a cable of up to 192 fibers and are further protected by various layers as described in Paragraph 3.10.4.3. Plastic fibers must not be used.

**Table 5. Single-mode Dual-windowed Fiber Cable Characteristics**

| Function | Parameters |
|---|---|
| Maximum Attenuation dB/km @ 1,310 nm | *****0.35 |
| Maximum Attenuation dB/km @ 1,550 nm | *****0.25 |
| Core Diameter Microns | 8.3 (nominal) |
| Core Eccentricity | Less than or equal to 1.0 micron |
| Cladding Diameter Microns | 125 +/-2 |
| Coating Diameter Microns | 250 +/-2 |
| Mode Field Diameter Microns | 8.8 +/-0.5 |
| Zero Dispersion Range | 1310 +/-010 nm |
| Maximum Dispersion Range | 3.2 ps/nm - km (range 1,285 to 1330 nm)<br>19 ps/nm - km (range 1,550 nm) |
| Refractive Index | 0.37% |
| Cable Tensile Load Rating | 600 lb (Note 3) |
| Cable Minimum Bending Radius | ******15 x cable diameter under no load. 0-800 N (0-180 lb) (Note 3). 20 x cable diameter under load. 800-2,700 N (181-600 lb). |
| *****Building/Breakout Cables (Tight Buffer). Maximum attenuations do not apply to tight buffered, breakout-type cables. Maximum attenuation for tight buffered cable is 1.25 dB/km @ 1,310 nm and 1.0 dB/km @ 1,550 dB/km. ******Building/Breakout Cables (Tight Buffer). Tensile load rating and minimum bending radius do not apply to tight buffered, breakout-type cables. | |

ps=picosecond

c. Non-zero Dispersion-shifted Fiber (NZDSF) – Fiber optic cables installed to support dense wave division multiplexing (DWDM) as identified in the design package must be NZDSF optic cable when the distance exceeds 25 miles. The NZDSF cables must meet or exceed the recommendations of International Telecommunication Union (ITU)-Telecommunication Standardization Sector (ITU-T) G.655, (03/2003) “Characteristics of a non-zero dispersion shifted single-mode optical fiber cable,” (Reference: Table 1/G.655-G.655A and Table 2/G.655-G.655B). Table 6 is an extraction of the ITU-T G.655. If the use of standard fiber versus non-zero dispersion-shifted fiber for the distance is in question, than an analysis should be performed to determine which fiber will best support channel capacity for the distance the cable is to be installed.

**Table 6. Non-zero Dispersion-shifted Single-mode FOC Characteristics**

| **Fiber Attributes** | | |
|---|---|---|
| **Attribute** | **Detail** | **Value** |
| Mode Field Diameter | Wavelength | 1,550 nm |
| | Range of nominal values | 8-11 μm |
| | Tolerance | ± 0.7 μm |
| Cladding Diameter | Nominal | 125 μm |
| | Tolerance | ± 1 μm |
| Core Concentricity Error | Maximum | 0.8 μm |
| Cladding Noncircularity | Maximum | 2.0 % |
| Cable Cut-off Wavelength | Maximum | 1,450 nm |
| Macrobend Loss | Radius | 30 mm |
| | Number of turns | 100 |
| | Maximum at 1,550 nm | 0.50 dB |
| Proof Stress | Minimum | 0.69 GPa |
| Chromatic Dispersion Coefficient Wavelength Range: 1,530-1,565 nm | $\lambda_{min}$ and $\lambda_{max}$ | 1,530 and 1,565 nm |
| | Minimum value of $D_{min}$ | 0.1 ps/nm·km |
| | Maximum value of $D_{max}$ | 6.0 ps/nm·km<br>10.0 ps/nm·km* |
| | Sign | Positive or negative |
| | $D_{max}$ - $D_{min}$* | ≤5.0 ps/nm·km* |
| Uncabled Fiber PMD Coefficient | Maximum | (see note). |
| Attenuation Coefficient | Maximum at 1,550 nm | 0.35 dB/km |
| PMD Coefficient | M | 20 cables |
| | Q | 0.01 % |
| | Maximum $PMD_Q$ | 0.5 ps/√km |
| **Note:** An optional maximum PMD coefficient on uncabled fiber may be specified by cablers to support the primary requirement on cable PMD link design value ($PMD_Q$), if it was demonstrated for a particular cable construction. | | |

* Values that apply to systems with minimum channel spacing of 100 GHz or less.

λ=wavelength; μm=micrometer; D=Chromatic Dispersion Coefficient; GHz=gigahertz; GPa=gigapascal; M=cable sections; PMD=polarization mode dispersion; Q=small probability level

### 3.15.4.3 Temperature Range.

Outdoor cables must have an operating and storage range of -40 to +70 degrees C. Indoor cables must have an operating and storage range of -20 to +70 degrees C. Cables must perform to their specified attenuation over the entire temperature range specified above. The attenuation must not vary by more than 0.2 dB/km for single-mode fibers, 0.5 dB/km for multimode fibers, and must never exceed specified attenuation limits.

### 3.15.4.4 Fiber Cable Count Assignment.

Fiber optic cable strand counts must be assigned in a similar manner as copper counts. The high number counts must be dropped first, and the strand one count must be the farthest from the serving node.

### 3.15.4.5 Use of Innerduct/Subduct/Fabric Mesh.

For underground installation, each FOC must be installed in innerduct, fabric mesh, or subduct. Fiber optic cable must not be installed directly in a 4-inch (100-mm) duct.

### 3.15.4.6 Splices and Power Budget.

a. Mechanical or fusion splicing must be used for FOC only if the mean splice loss is less than or equal to 0.1 dB. No individual splice must exceed 0.3 dB.

b. In accordance with RUS Bulletin 1751F-642 for buried FOC plant, DB, filled, and/or splice cases installed in MHs and hand holes must be used.

c. Loop-through splicing must be used in lieu of homeruns/dedicated cables to the serving location. In loop-through splicing, only the fiber strands breaking off from the main cable to enter a building are cut and spliced. The other fibers are not cut. The sheath is cut from the cable, exiting fibers are cut and spliced, and remaining fibers are folded back within the case (not cut) and then routed on.

### 3.15.4.7 Manufactured Outside Plant Cable Assemblies.

A manufactured OSP cable assembly will be an FOC that is manufactured with connection points that allow for the connection of smaller FOCs to be attached without splicing in the field. The manufactured OSP assembly will be constructed in such a matter that the assembly can be installed either in a conduit, DB, or aerial system and will not be adversely affected by its environment any more than the traditional fiber cable products.

The use of manufactured OSP cable assemblies is permitted in outside plant designs. The connection points should be selected to meet the overall design of the cable system.

### 3.15.5 Transfers, Cuts, and Throws.

Cable transfers, cuts, and throws must be performed to maximize existing resources. All cables and terminals affected by cable count transfers must be retagged in the field to reflect the new changes.

## 3.16 Main Distribution Frame.

The MDF is the interface between the OSP cable and the switch cables. The iron framework of the MDF supports the horizontal blocks and vertical connectors. The MDF must be equipped with guard rails and end rails. The engineer must provide new vertical sections to support all newly installed cable if none are available. A minimum of 760 mm (30 inches) of clearance around the frame is required for safety.

### 3.16.1 Horizontal Blocks.

The horizontal blocks terminate the cables between the switch and the MDF. Each connection corresponds to a telephone number on the switch. The switch engineer must determine the number of horizontal blocks on the frame. All horizontal blocks must be stenciled to show the termination IDs.

### 3.16.2 Vertical Connectors.

The vertical connectors are mounted on the vertical side of the MDF. Each connector protects 100 or 200 pairs of the OSP cables. The connector is equipped with tip cables that are pre-terminated on the connector. The tip cables are routed from the MDF through the floor to the cable vault or over the MDF to the wall, where they are spliced to the OSP cable. The connectors for the tip cables must be provided as either stub-up or stub-down as determined by the type of installation required. The vertical connectors protect the electronics in the DCO by providing lightning and surge protection. Each termination corresponds to a pair of the OSP cables. All OSP cable pairs must be terminated on connectors. All vertical connectors must be stenciled to show the cable number and the pair counts for all connectors on that vertical connector. All connectors must show the count terminated. A schematic showing the vertical side of the MDF is shown in Figure C-7 (Figure C-15 for Europe) – MDF and Cable Vault Schematic. Space-saver type MDF connectors must be used, unless otherwise directed by the U.S. Government.

#### 3.16.3 Cross-connects.

Cross-connects should be installed between the OSP terminations on the vertical connectors and the switch terminations on the horizontal blocks. This process connects an OSP pair to a telephone number. Approximately 8 inches (200 mm) of slack must be left in the cross-connect wire to allow re-termination for moves, additions, or changes.

#### 3.16.4 Special Circuits.

Since special circuits (such as data circuits, T-1s, or alarms) are non-switched, they must be treated differently than voice and modem circuits. The protector modules must be marked IAW the existing site procedure to indicate a special circuit. Various colors of protector modules are available to help in this differentiation. The special circuits must be cross-connected to designated blocks on the horizontal side (not to the switch blocks).

### 3.17 Building Terminations.

#### 3.17.1 PETs.

All OSP copper cables must be terminated on primary protector blocks, equipped with 5-pin solid state or gas protector modules.

#### 3.17.2 Terminals and Hardware.

Terminals and hardware must be UL listed, and must be made of a flame-retardant construction and equipped with a built-in splice chamber; 5-pin gas protector modules, locking cover, and output on 66 blocks, 110 blocks, or RJ21 connectors. The PET for European projects will be equipped with protected, line sharing adapter (LSA+) terminal blocks. All PETs must be connected to the lightning protection grounding system for the building.

#### 3.17.3 Fiber Patch Panels.

##### 3.17.3.1 Fiber Termination Device.

All strands of FOCs, both OSP and inside plant, will be properly terminated on FOPPs. The OSP plant FOC will be extended IAW the NEC standards into the main data closet/location of the building and terminated there. If the main data closet/location cannot be determined, the OSP FOC will be terminated on a lockable patch panel collocated with the copper PET. Inside plant FO riser cables between the main data closet/location and any satellite data closet(s)/location(s) will be terminated at both locations on the FOPPs. All FOPPs will be stenciled with the panel number and the cable count.

##### 3.17.3.2 Fiber Terminations.

All terminations will be made using SC or ST connectors.

## 3.18 Grounding.

All unclassified TRs must be connected to the building EES IAW MIL-STD-188-124-B. Information on grounding of classified facilities can be found in MIL-STD-188-124-B and MIL-HDBK-419-A. Figure C-17of Appendix C provides detailed schematics for the signal grounding system. An acceptable grounding system encompasses: fault protection grounds, lightning protection grounds, signal grounds, and DC power grounds (when applicable). Refer to NFPA 780 and MIL-HDBK-419-A for proper lightning protection and NFPA 70

for proper fault protection grounding. The telecommunications designer must review project drawing to ensure that the lightning and fault protection grounds are addressed by the appropriate disciplines. The telecommunications designer must ensure that the different grounding systems are not mixed within the building.

### 3.18.1 Building Ground.

The building EES forms the primary electrical, life-safety grounding system. Typically, a grounding electrode conductor connects the main building-grounding electrode to the main electrical entrance panel or cabinet. NFPA 70, Article 250 Section III provides guidance on the grounding electrode system and conductor. The EUBs and ADNs should have a resistance-to-earth of 10 ohms or less, following MIL-STD-188-124-B. The switch manufacturers may specify the resistance-to-earth as 5 ohms or less for a telephone switch or DCO. The designer should be conscious of the proposed utilization of the facility and plan accordingly. Sites must provide proper supporting documentation and specifications to the designer to support resistance-to-ground requirements more stringent than that of NFPA 70 or MIL-STD-188-124-B for non-voice switch buildings. Proper documentation includes international, national or local codes, DOD and DA standards, or manufacturers' equipment specifications.

### 3.18.2 Cable Entrance Grounding.

All metallic shields and strength members for OSP cable entering a building must be connected to the lightning protection ground system. The designer must ensure that the lightning protection is IAW MIL-STD-188-124-B and NFPA 780, *Standard for the Installation of Lightning Protection Systems*, latest issue.

#### 3.18.2.1 Building Point of Entrance.

The NFPA 70 defines the point of entrance as the location where "the wire or cable emerges from an external wall, from a concrete floor-slab, or from a rigid metal conduit or an IMC grounded to an electrode IAW 800.400-B." The Telecommunications Entrance Facility (TEF) is the space housing the point of entrance of the telecommunications service.

#### 3.18.2.2 Copper Cable Entrance.

The OSP copper cable shield, armor, and metallic strength member must be bonded to the lightning protection ground as close as possible to the building point of entrance with a No. 6 AWG or larger ground wire. The designer should use a non-bonded splice case for the transition from OSP rated cable to interior rated cable or must indicate that the implementer not install the splice case carry-through bonding conductor. If the designer must extend the OSP copper cable past 50 feet (15 m) IAW NFPA 70 Section 800.50, the metallic strength member must be bonded to the lightning protection ground as close as possible to the conduit egress point with a No. 6 AWG or larger copper ground wire.

#### 3.18.2.3 Fiber Cable Entrance.

The OSP FOC armor and metallic strength member must be bonded to the lightning protection ground as close as possible to the building point of entrance with a No. 6 AWG or larger ground wire. The designer should use a non-bonded splice case for the transition from OSP rated cable to interior rated cable or must indicate that the implementer not install the splice case carry-through bonding conductor. If the designer must extend the OSP fiber cable past 50 feet IAW NFPA 70 Section 770.50, the metallic strength member must be bonded to the lightning protection ground as close as possible to the conduit egress point with a No. 6 AWG or larger copper ground wire. If inside/outside cable is used, a cable shield isolation gap must be incorporated.

#### 3.18.2.4 Copper Protector Block.

All OSP copper cables must be terminated on primary protector blocks, equipped with 5-pin solid state or gas protector modules. The protector blocks must be bonded to the lightning protection ground with a No. 6 AWG or larger copper ground wire. Terminals and hardware must be UL-listed, made of a flame-retardant construction, and equipped with a built-in splice chamber; 5-pin gas protector modules, locking cover, and output on 66 blocks, 110 blocks, or RJ21 connectors. The PET for European projects will be equipped with protected, LSA+ terminal blocks. All PETs must be connected to the lightning protection grounding system for the building. Place the protector block as close as possible to the lightning protection ground.

## 3.19 Final Acceptance Test.

### 3.19.1 Telecommunications Cable Plant.

Testing will consist of, but will not be limited to, the following cable tests:

- Insulation resistance
- Shorts/crosses
- Grounds
- Opens
- Reversals
- Splits
- Transpositions
- Shield continuity
- Loop resistance
- Insertion loss (performed only when specified)
- Capacitance

### 3.19.2 FOC.

Testing will consist of Optical Time Domain Reflectometer (OTDR) measurements for one strand in each 12-strand bundle of fiber, and Power Source/Power Meter tests on every strand in all cables. Each strand of fiber cable not terminated at each end will be tested with the OTDR. While using the OTDR, measure the length of the strand and look for any circuit discontinuities and/or splice points. Run a strip chart for each fiber strand tested and record the cable ID, strand ID, source location, meter location, and dB loss at each specified nm wavelength and fiber length, and note whether the strand passed or failed the test. The following tests will also be included as a minimum:

- Attenuation
- Bandwidth
- Power Source/Power Meter: This test will consist of bi-directional, dual-window (1,300/1,550 nm) testing of every fiber strand installed.

Table 7 shows the standard cable reel lengths and diameters.

**Table 7. Standard Cable Reel Lengths and Diameters**

| Cable Type | Number of Pairs | AWG | Standard Length (ft) | Nominal Diameter (in) |
|---|---|---|---|---|
| PE-22 | 6 x | 19 | 5,000 | 0.53 |
| Air Core | 12 x | 19 | 5,000 | 0.6 |
| Alpeth | 25 | 19 | 5,000 | 0.81 |
| Sheath | 50 | 19 | 2,500 | 1.08 |
| | 6 x | 22 | 5,000 | 0.43 |
| | 12 x | 22 | 5,000 | 0.53 |
| | 25 | 22 | 5,000 | 0.7 |
| | 50 | 22 | 5,000 | 0.85 |
| | 100 | 22 | 5,000 | 1.07 |
| | 200 | 22 | 5,000 | 1.48 |
| | 300 | 22 | 2,000 | 1.75 |
| | 400 | 22 | 2,000 | 1.96 |
| | 600 | 22 | 1,000 | 2.44 |
| | 900 | 22 | 1,000 | 2.88 |
| | 1,200 | 22 | 750 | 3.29 |
| | 6 x | 24 | 10,000 | 0.41 |
| | 12 x | 24 | 10,000 | 0.46 |
| | 25 | 24 | 10,000 | 0.55 |
| | 50 | 24 | 5,000 | 0.66 |
| | 100 | 24 | 5,000 | 0.87 |
| | 200 | 24 | 5,000 | 1.18 |
| | 300 | 24 | 2,500 | 1.38 |
| | 400 | 24 | 2,500 | 1.53 |
| | 600 | 24 | 2,500 | 1.85 |
| | 900 | 24 | 1,500 | 2.31 |
| | 1,200 | 24 | 1,000 | 2.69 |

Table 7. Standard Cable Reel Lengths and Diameters (continued)

| Cable Type | Number of Pairs | AWG | Standard Length (ft) | Nominal Diameter (in) |
|---|---|---|---|---|
| | 1,500 | 24 | 1,000 | 2.92 |
| | 1,800 | 24 | 750 | 3.01 |
| | 2,100 | 24 | 500 | 3.39 |
| | 25 | 26 | 10,000 | 0.49 |
| | 50 | 26 | 10,000 | 0.57 |
| | 100 | 26 | 10,000 | 0.71 |
| | 200 | 26 | 5,000 | 0.97 |
| | 300 | 26 | 5,000 | 1.14 |
| | 400 | 26 | 5,000 | 1.30 |
| | 600 | 26 | 2,500 | 1.54 |
| | 900 | 26 | 2,500 | 1.88 |
| | 1,200 | 26 | 1,500 | 2.10 |
| | 1,500 | 26 | 1,500 | 2.32 |
| | 1,800 | 26 | 1,000 | 2.48 |
| | 2,100 | 26 | 1,000 | 2.68 |
| | 2,400 | 26 | 1,000 | 2.90 |
| | 2,700 | 26 | 1,000 | 3.03 |
| | 3,000 | 26 | 750 | 3.20 |
| Figure-8 | 6 x | 22 | 9,930 | 0.96 |
| Filled | 12 x | 22 | 9,930 | 1 |
| Alpeth | 25 | 22 | 9,810 | 1.16 |
| Sheath | 50 | 22 | 6,540 | 1.34 |
| | 6 x | 24 | 11,340 | 0.88 |
| | 12 x | 24 | 11,340 | 0.96 |
| | 25 | 24 | 11,340 | 1.02 |
| | 50 | 24 | 11,340 | 1.18 |
| | 50 | 26 | 13,320 | 1.08 |
| | 100 | 26 | 8,820 | 1.26 |
| PE-89 | 6 x | 19 | 5,000 | 0.52 |
| Filled | 12 x | 19 | 5,000 | 0.62 |
| Alpeth | 25 | 19 | 5,000 | 0.86 |
| Sheath | 50 | 19 | 5,000 | 1.12 |
| | 100 | 19 | 2,500 | 1.51 |
| | 200 | 19 | 1,500 | 2.04 |
| | 6 x | 22 | 5,000 | 0.48 |
| | 12 x | 22 | 5,000 | 0.52 |
| | 25 | 22 | 5,000 | 0.66 |
| | 50 | 22 | 5,000 | 0.86 |
| | 75 | 22 | 5,000 | 0.96 |
| | 100 | 22 | 5,000 | 1.1 |
| | 150 | 22 | 5,000 | 1.32 |
| | 200 | 22 | 2,500 | 1.49 |

Table 7. Standard Cable Reel Lengths and Diameters (continued)

| Cable Type | Number of Pairs | AWG | Standard Length (ft) | Nominal Diameter (in) |
|---|---|---|---|---|
| | 300 | 22 | 2,000 | 1.72 |
| | 400 | 22 | 2,000 | 1.96 |
| | 600 | 22 | 1,000 | 2.4 |
| | 900 | 22 | 1,000 | 2.9 |
| | 1,200 | 22 | 750 | 3.28 |
| | 6 x | 24 | 10,000 | 0.44 |
| | 12 x | 24 | 10,000 | 0.48 |
| | 25 | 24 | 10,000 | 0.58 |
| | 50 | 24 | 10,000 | 0.7 |
| | 75 | 24 | 5,000 | 0.86 |
| | 100 | 24 | 5,000 | 0.94 |
| | 150 | 24 | 5,000 | 1.06 |
| | 200 | 24 | 5,000 | 1.2 |
| | 300 | 24 | 2,500 | 1.45 |
| | 400 | 24 | 2,000 | 1.59 |
| | 600 | 24 | 2,000 | 1.92 |
| | 900 | 24 | 1,000 | 2.32 |
| | 1,200 | 24 | 1,000 | 2.68 |
| | 1,500 | 24 | 1,000 | 2.92 |
| | 1,800 | 24 | 750 | 3.2 |
| | 2,100 | 24 | 600 | 3.44 |
| | 25 | 26 | 10,000 | 0.52 |
| | 50 | 26 | 10,000 | 0.58 |
| | 100 | 26 | 10,000 | 0.78 |
| | 200 | 26 | 5,000 | 1.02 |
| | 300 | 26 | 5,000 | 1.18 |
| | 400 | 26 | 5,000 | 1.33 |
| | 600 | 26 | 2,500 | 1.59 |
| | 900 | 26 | 2,000 | 1.92 |
| | 1,200 | 26 | 1,500 | 2.1 |
| | 1,500 | 26 | 1,000 | 2.34 |
| | 1,800 | 26 | 1,000 | 2.6 |
| | 2,100 | 26 | 1,000 | 2.78 |
| | 2,400 | 26 | 1,000 | 2.92 |
| | 2,700 | 26 | 750 | 3.14 |
| | 3,000 | 26 | 750 | 3.24 |
| | 6 x | 19 | 5,000 | 0.58 |
| PE-89 | 12 x | 19 | 5,000 | 0.66 |
| Filled | 25 | 19 | 5,000 | 0.9 |
| Rodent | 50 | 19 | 2,500 | 1.18 |
| Protected | 6 x | 22 | 5,000 | 0.54 |
| Alpeth | 12 x | 22 | 5,000 | 0.58 |

Table 7. Standard Cable Reel Lengths and Diameters (continued)

| **Cable Type** | **Number of Pairs** | **AWG** | **Standard Length (ft)** | **Nominal Diameter (in)** |
|---|---|---|---|---|
| Sheath | 25 | 22 | 5,000 | 0.7 |
| | 50 | 22 | 5,000 | 0.9 |
| | 100 | 22 | 5,000 | 1.14 |
| | 200 | 22 | 2,500 | 1.51 |
| | 300 | 22 | 2,000 | 1.76 |
| | 400 | 22 | 2,000 | 2 |
| | 600 | 22 | 1,000 | 2.46 |
| | 900 | 22 | 1,000 | 2.94 |
| | 1,200 | 22 | 750 | 3.28 |
| | 6 x | 24 | 10,000 | 0.5 |
| | 12 x | 24 | 10,000 | 0.54 |
| | 25 | 24 | 10,000 | 0.58 |
| | 50 | 24 | 10,000 | 0.74 |
| | 100 | 24 | 5,000 | 0.98 |
| | 200 | 24 | 5,000 | 1.26 |
| | 300 | 24 | 2,500 | 1.49 |
| | 400 | 24 | 2,000 | 1.63 |
| | 600 | 24 | 2,000 | 1.96 |
| | 900 | 24 | 1,000 | 2.36 |
| | 1,200 | 24 | 1,000 | 2.68 |
| | 1,500 | 24 | 1,000 | 2.94 |
| | 1,800 | 24 | 750 | 3.22 |
| | 25 | 26 | 10,000 | 0.58 |
| | 50 | 26 | 10,000 | 0.66 |
| | 100 | 26 | 10,000 | 0.82 |
| | 200 | 26 | 5,000 | 1.08 |
| | 300 | 26 | 5,000 | 1.22 |
| | 400 | 26 | 5,000 | 1.38 |
| | 600 | 26 | 2,500 | 1.63 |
| | 900 | 26 | 2,000 | 1.92 |
| | 1,200 | 26 | 1,500 | 2.11 |
| | 1,500 | 26 | 1,000 | 2.36 |
| | 1,800 | 26 | 1,000 | 2.62 |
| | 2,100 | 26 | 1,000 | 2.78 |
| | 2,400 | 26 | 1,000 | 2.94 |
| | 2,700 | 26 | 750 | 3.18 |
| | 3,000 | 26 | 750 | 3.26 |

Table 8 shows the European standard cable reel lengths and diameters.

**Table 8. European Standard Cable Reel Lengths and Diameters**

| Cable Type | Number of Pairs | Conductor Size (mm) | Standard Reel Length (m) | Nominal Outside Diameter mm (in) |
|---|---|---|---|---|
| A-2YF(L)2Y | 2 | 0.6 | Special order only | 9.0 (0.35) |
| PE insulation | 4 | 0.6 | Special order only | 11.5 (0.45) |
| Jelly filled cable core | 6 | 0.6 | 1,000 | 12.0 (0.47) |
| Laminated sheath | 10 | 0.6 | 1,000 | 13.5 (0.53) |
| DIN VDE 0816 | 20 | 0.6 | 1,000 | 16.5 (0.65) |
| | 30 | 0.6 | 1,000 | 19.5 (0.77) |
| | 50 | 0.6 | 1,000 | 23.5 (0.93) |
| | 100 | 0.6 | 1,000 | 31.5 (1.24) |
| | 150 | 0.6 | 1,000 | 37.5 (1.48) |
| | 200 | 0.6 | 1,000 | 42.5 (1.67) |
| | 300 | 0.6 | 500 | 52.0 (2.05) |
| | 500 | 0.6 | 300 | 67.0 (2.64) |
| | 600 | 0.6 | 300 | 74.0 (2.91) |
| | 800 | 0.6 | 300 | 85.0 (3.35) |
| A-2YF(L)2Y | 6 | 0.8 | 1,000 | 13.0 (0.51) |
| PE insulation | 10 | 0.8 | 1,000 | 15.0 (0.59) |
| Jelly filled cable core | 20 | 0.8 | 1,000 | 18.0 (0.71) |
| Laminated sheath | 30 | 0.8 | 1,000 | 21.0 (0.83) |
| DIN VDE 0816 | 50 | 0.8 | 1,000 | 26.0 (1.02) |
| | 100 | 0.8 | 1,000 | 34.0 (1.34) |
| | 150 | 0.8 | 500 | 40.0 (1.57) |
| | 200 | 0.8 | 500 | 47.0 (1.85) |
| | 300 | 0.8 | 300 | 61.0 (2.40) |
| | 500 | 0.8 | 300 | 78.0 (3.07) |

Table 9 shows a sample of a cable spreadsheet.

**Table 9. Cable Spreadsheet Sample**

| Termination | Required Copper Pairs | Served From | Copper Cable & Count | Required Fiber Strands | Served From | Fiber Cable & Count | Priority | Remarks |
|---|---|---|---|---|---|---|---|---|
| MH 5 | 900 | B 376 | 6, 1-900 C/C | N/A | N/A | N/A | Phase 1 | |
| B 390 | 900 | B 376 | 6, 901-1,800 | 192 | B 376 | FOC A, 1-192 | Phase 1 | Backbone fiber to ADN. |
| B 220 | 50 | B 376 | 7, 1-50 | 12 | B 376 | FOC A-2, 25-36 | Phase 2 | |
| B 218 | 100 | B 376 | 7, 51-150 | 12 | B 376 | FOC A-2, 37-48 | Phase 2 | |
| B 219 | 100 | B 376 | 7, 151-250 | 12 | B 376 | FOC A-2, 49-60 | Phase 2 | |
| B 233 | 50 | B 376 | 7, 251-300 | 12 | B 376 | FOC A-2, 61-72 | Phase 2 | |
| B 223 | 100 | B 376 | 7, 301-400 | 12 | B 376 | FOC A-2, 73-84 | Phase 2 | |
| B 224 | 200 | B 376 | 7, 401-600 | 12 | B 376 | FOC A-2, 85-96 | Phase 2 | |
| B 231 | 100 | B 376 | 7, 601-700 | 12 | B 376 | FOC A-2, 97-108 | Phase 2 | |
| B 228 | 100 | B 376 | 7, 701-800 | 12 | B 376 | FOC A-2, 109-120 | Phase 2 | |
| B 227 | 100 | B 376 | 7, 801-900 | 12 | B 376 | FOC A-2, 121-132 | Phase 2 | |
| B 225 | 100 | B 376 | 7, 901-1,000 | 12 | B 376 | FOC A-2, 133-144 | Phase 2 | |
| B 202 | 100 | B 376 | 7, 1001-1,100 | 12 | B 376 | FOC A-1, 1-12 | Phase 2 | |
| B 203 | 100 | B 376 | 7, 1101-1,200 | 12 | B 376 | FOC A-1, 13-24 | Phase 2 | |
| B 214 | 100 | B 376 | 7, 1201-1,300 | 12 | B 376 | FOC A-1, 25-36 | Phase 2 | |
| B 204 | 100 | B 376 | 7, 1501-1,600 | 12 | B 376 | FOC A-1, 37-48 | Phase 2 | |
| B 212 | 100 | B 376 | 7, 1401-1,500 | 12 | B 376 | FOC A-1, 49-60 | Phase 2 | |
| B 206 | 100 | B 376 | 7, 1301-1,400 | 12 | B 376 | FOC A-1, 61-72 | Phase 2 | |
| B 192 | 100 | B 376 | 7, 1601-1,700 | 12 | B 376 | FOC A-1, 73-84 | Phase 2 | |
| B 193 | 100 | B 376 | 7, 1701-1,800 | 12 | B 376 | FOC A-1, 85-96 | Phase 2 | |
| B 399 | | | | 12 | B 376 | FOC D1, 1-12 | Phase 2 | LAN C-DCO is B 376. |

## 4.0 VOICE SWITCHING, CENTRAL OFFICE/END OFFICE, AND CONVERGENCE.

Voice switching architecture and technology is addressed in *USAISEC TG for Circuit Switching*. The information previously provided in the section entitled Dial Central Office/Remote Switching Unit is also included in the *TG for Circuit Switching*. The circuit switching guide provides generic technical guidance for the design of telephone systems that support U.S. Army facilities. The document contains design guidance related to identifying system requirements, supporting engineering site surveys, performing new construction planning and systems designs, in support of procuring, engineering, installing, testing, and cutting over administrative telephone systems within the boundaries of U.S. Army installations. The document is currently under review for revisions and updates.

The convergence of voice, data, and video is addressed in the *Voice over Internet Protocol Design Guidelines*, currently in Draft. The document describes the design requirements that will be used to implement VoIP. The TG incorporates regulatory policies and guidance as well as best business practices within industry. The document applies to both converged and non-converged networks, as defined within the DISA GSCR.

## 5.0 NETWORK ARCHITECTURE.

The network architecture topology normally follows the existing telephone topology. Geographic dispersion, number of users in the area, available space for electronics equipment, existing cable and duct system, and identified areas of future growth are also considered when selecting core node locations. The converged architecture will provide a common IP based transport for all Non-secure IP Router Network, encrypted SIPRNET, Non-authenticated Users, Synchronous Optical Network (SONET), and Sensitive Information voice, data, and video services on the post, camp or station network. The converged architecture provides a core node backbone using carrier class switching to provide a high degree of scalability and availability to all required services as described in the U.S. Army Network Enterprise Technology Command (NETCOM) Horse Blanket LandWarNet LAN/campus area network (CAN) technical profile.

Data network architecture and technology is addressed in *USAISEC TIC Installation Information Infrastructure Modernization Program (I3MP) Data Performance Guide*.

## 6.0 NETWORK AND SYSTEMS MANAGEMENT.

### 6.1 Introduction.

System and network management is becoming increasingly important in today's environment of distributed applications and heightened security and is addressed in *USAISEC TG for Network and Systems Management (NSM)*. Network and system administrators rely heavily on automated NSM tools for tasks such as discovering, diagnosing and correcting problems, updating software, and maintaining network/system operations. Managing networks and systems is a difficult and complicated task requiring extensive knowledge in numerous areas such as operating systems, networking devices and protocols, addressing, databases, applications, and others. NSM systems are intended to ease the burden on resources associated with these tasks.

### 6.1.1 NSM Objectives.

The objective of an NSM is to provide effective, responsive, and proactive management of networks and systems with minimal life-cycle support costs. This includes the integration of lower level management systems and subsystems to provide an enterprise view of the network and system assets. The primary uses of NSM are:

- Provide backup and recovery services
- Monitor, identify, track, and correct information system and network communication failures
- Monitor, identify, and correct network and system security problems
- Monitor, control, and fine tune network and systems performance
- Identify communication and processing resource usage
- Manage inventory and distribute software information assurance and security

### 6.2 Purpose.

The *USAISEC Security Engineering TG* defines the process for performing Information System Security (ISS) Engineering (ISSE) at the USAISEC. The Information Assurance Technical Framework (IATF), Version 3.0, September 2000, defines ISSE as the process for addressing a user's information protection needs and is part of the systems engineering, systems acquisition, risk management, certification and accreditation (C&A) and the life cycle support processes. The *USAISEC Security Engineering TG* presents the IATF description for ISSE, but also defines how this process is implemented by USAISEC within the U.S. Army.

## 7.0 WIRELESS LOCAL AREA NETWORK.

The *USAISEC Wireless Local Area Network Architecture TG* provides detailed guidance on WLAN implementation for edge connectivity.

# APPENDIX A. TECHNICAL GUIDANCE CHECKLIST FOR INSTALLATION INFORMATION INFRASTRUCTURE ARCHITECTURE

| Item | Compliance<br>Y N N/A<br>Not addressed | TG Paragraph | Standard and Section | Requirement | Comments |
|---|---|---|---|---|---|
| | | 2.0 | TIA/EIA-568-B and TIA/EIA-569-B | Does this project include structured BCSs? | Continue through this checklist and TG for detailed information on BCS implementation. |
| | | 2.1 | | Does this project include a secure information systems infrastructure? | Refer to the USAISEC TG for the Integration of SIPRNET (January 2006) |
| | | 2.3 | TIA/EIA-568-B and TIA/EIA-569-B | Design the workstation outlet configuration, locations and densities IAW sub-paragraphs 2.3.1 through 2.3.10 | |
| | | 2.4 | TIA/EIA-568-B | Specify standardized cabling types IAW paragraphs 2.4.1 through 2.4.3 | |
| | | 2.4.4 | TIA/EIA-569-B | Design the cabling infrastructure according to paragraphs 2.4.4.1 through 2.4.4.7 | |

| **Item** | **Compliance**<br>**Y N N/A**<br>**Not addressed** | **TG Paragraph** | **Standard and Section** | **Requirement** | **Comments** |
|---|---|---|---|---|---|
| | | 2.5 | TIA/EIA-568-B and TIA/EIA-569-B | Specify and provision the TRs according to paragraphs 2.5.1 through 2.5.16 | |
| | | 2.6 | MIL-HNBK-419-A MIL-STD-188-124-B NFPA 70 | Design the telecommunications grounding system IAW USAISEC TG and the specified standards. | The TG for USAISEC LPAGBS provides additional detail on overall grounding systems. |
| | | 2.7 | TIA/EIA-606-A | Specify the labeling and identification of the telecommunications system IAW paragraphs 2.7.1 through 2.7.5 | |
| | | 2.8 | TIA/EIA-568-B and TIA/EIA-569-B, TIA/EIA-758 | Design the cable entrance IAW paragraphs 2.8.1 through 2.8.3 | |
| | | 2.9 | TIA/EIA-568-B | Specify the complete testing of all installed cabling IAW paragraphs 2.9.1 through 2.9.4 | |

| Item | Compliance Y N N/A Not addressed | TG Paragraph | Standard and Section | Requirement | Comments |
|---|---|---|---|---|---|
| | | 3.0 | | Does this project include structured OSP Cabling Systems? | Continue through this checklist and TG for detailed information on Outside Plant Cabling Systems implementation. |
| | | 3.1 | | Does this project include a secure information systems infrastructure? | Refer to the USAISEC TG the Integration of SIPRNET (January 2006) |
| | | 3.3 | | Design the OSP to support the U.S. Army architecture and meet the requirements of the user. | |
| | | 3.5 | | Consider and document all environmental and historical concerns. | |
| | | 3.6 | | Conform to all general considerations when designing and executing an OSP project, as specified in paragraphs 3.6.1 through 3.6.10 | |
| | | 3.7 | | Select proper placement option for OSP location and application. | |
| | | 3.8 | | Conform to all underground construction considerations when designing and executing an underground OSP system. | The underground OSP system is the preferred method within the post, camp or station cantonment area. |

| Item | Compliance<br>Y N N/A<br>Not addressed | TG Paragraph | Standard and Section | Requirement | Comments |
|---|---|---|---|---|---|
| | | 3.9 | | Conform to all DB construction considerations when designing and executing a direct-buried OSP system. | |
| | | 3.10 | | Conform to paragraphs 3.10.1 through 3.10.4 when crossing or passing through OSP obstructions | |
| | | 3.11 | | Conform to all aerial cable construction considerations when designing and executing an aerial cable OSP system. | Aerial cable runs must be used only with U.S. Government approval in extenuating circumstances or for long runs outside of the cantonment area, as specified in the design package. |
| | | 3.12 | | Design any FSO links IAW section 3.12 and paragraphs 3.12.1 through 3.12.2 | FSO can provide an alternative to FO connectivity, for the "last mile," to EUBs and small enclaves, but must closely follow the performance and security requirements specified. |
| | | 3.13 | | Does this project include ranges, or is the project located on a range? | Design any range project or connectivity IAW the guidance and directions provided in paragraphs 3.13.1 through 3.13.4. |

| Item | Compliance<br>Y N N/A<br>Not addressed | TG Paragraph | Standard and Section | Requirement | Comments |
|---|---|---|---|---|---|
| | | 3.14 | | Does this project include piers, or is the project located on a pier? | Design any pier project or connectivity IAW the guidance and directions provided in paragraphs 3.14.1 through 3.14.3. |
| | | 3.15 | | Specify and install standardized cabling types in accordance with paragraphs 3.15.1 through 3.15.5 | |
| | | 3.16 | | Is an MDF installation or upgrade required in this project? Specify and install the MDF IAW paragraphs 3.16.1 through 3.16.4. | |
| | | 3.17 | | Design and install building terminations IAW paragraphs 3.17.1 through 3.17.3. | |
| | | 3.18 | MIL-HDBK-419-A<br>MIL-STD-188-124-B<br>NFPA 70 | Design the telecommunications grounding system IAW USAISEC technical guidance and the specified standards. | The TG for USAISEC LPAGBS provides additional detail on overall grounding systems. |
| | | 3.19 | | Specify the complete testing of all installed OSP cabling IAW paragraphs 3.19.1 through 3.19.2. | |

| Item | Compliance<br>Y N N/A<br>Not addressed | TG Paragraph | Standard and Section | Requirement | Comments |
|---|---|---|---|---|---|
| | | 4.0 | | Does this project include a voice switching system? | Voice switching architecture and technology is addressed in USAISEC TG for Circuit Switching. |
| | | 5.0 | | Does this project encompass the data backbone, or attach to the data core? | Data network architecture and technology is addressed in USAISEC TIC Installation Information Infrastructure Modernization Program (I3MP) Data Performance Guide |
| | | 6.0 | | Does this project encompass the data backbone, or attach to the data core? | System and network management is addressed in USAISEC TG for NSM. |

# APPENDIX B. BUILDING CABLING SYSTEM FIGURES

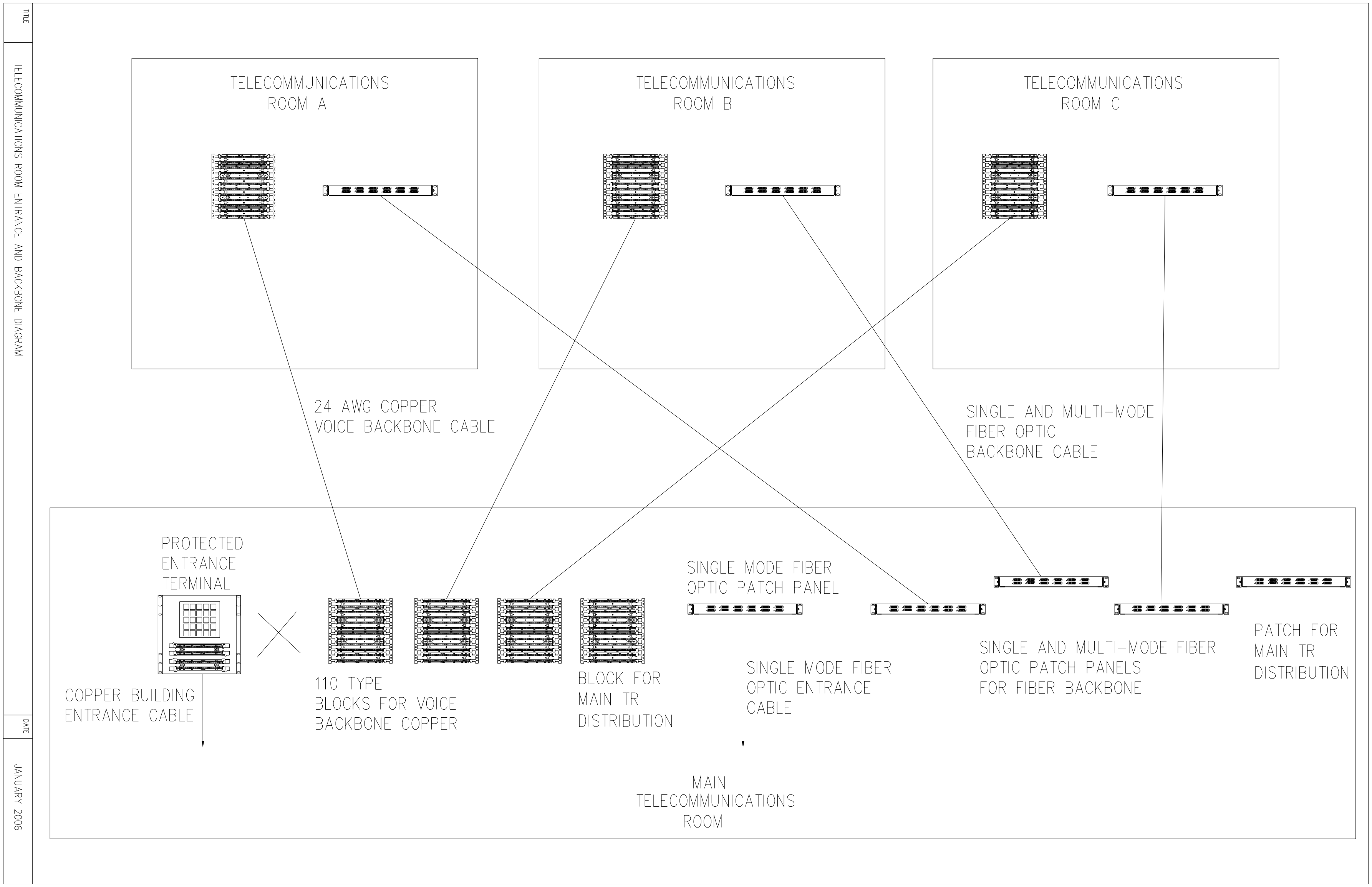



**Figure B-1. Telecommunications Room Entrance and Riser**

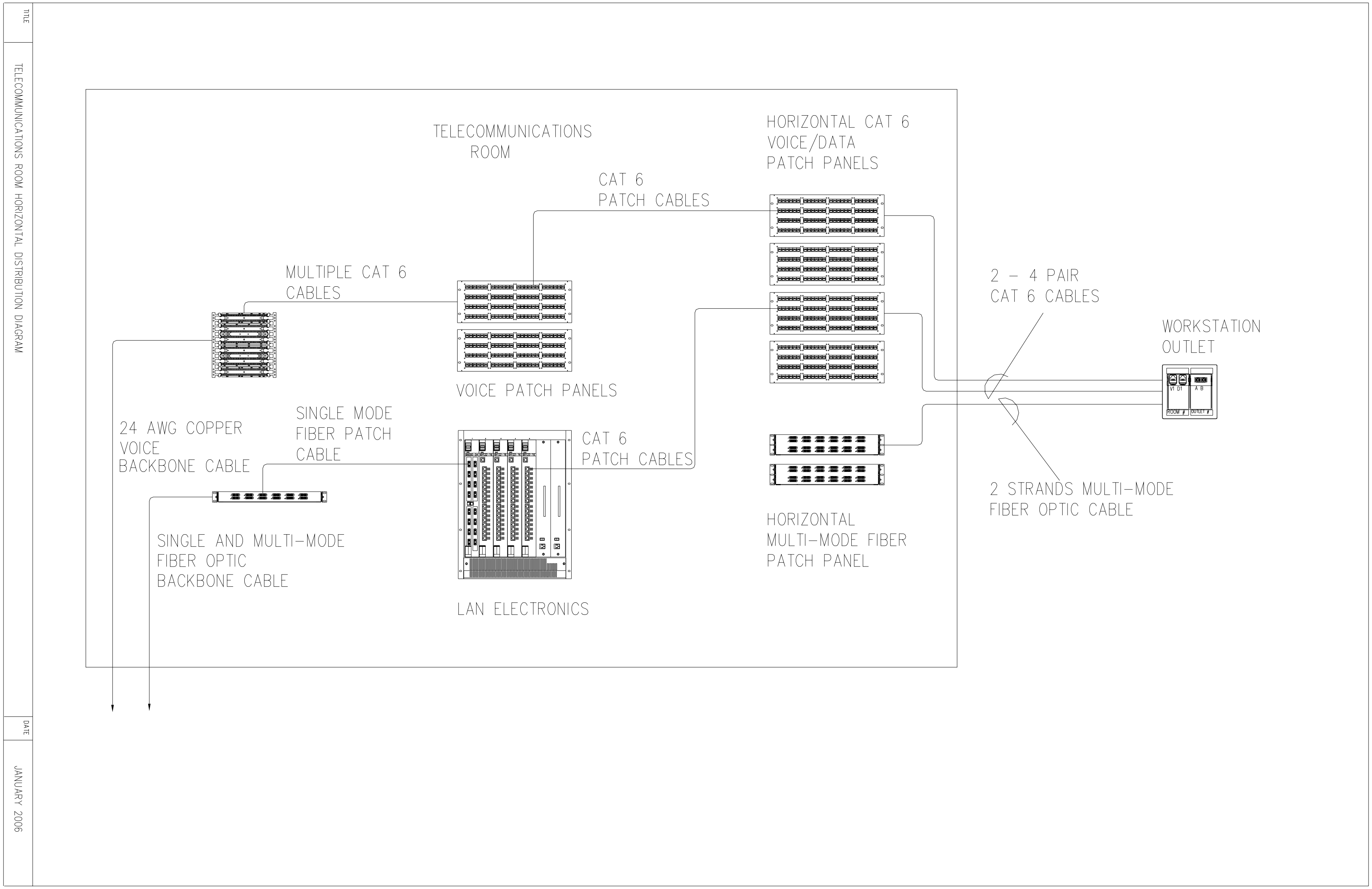



**Figure B-2. Telecommunications Room Horizontal Distribution**

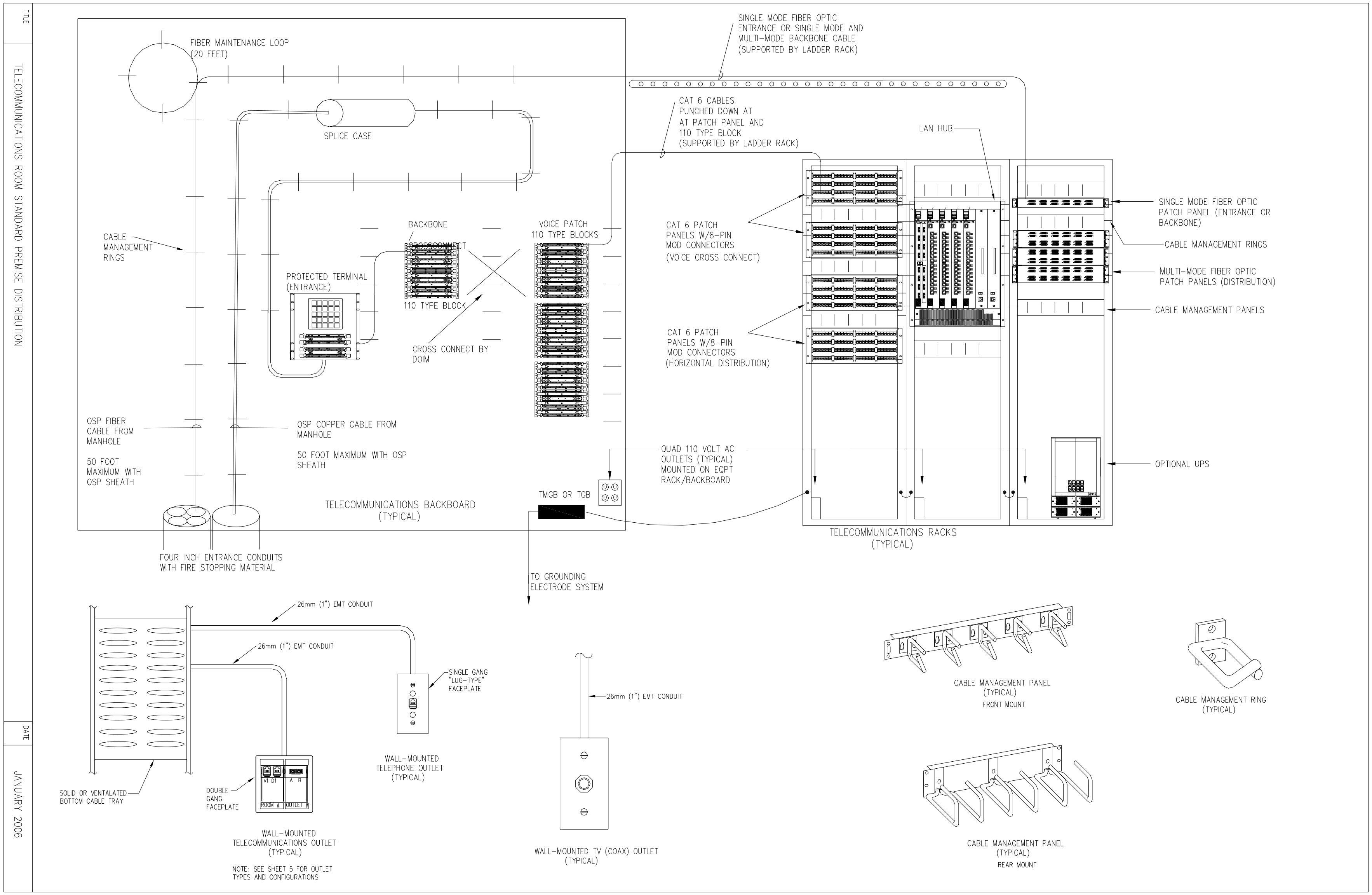



**Figure B-3. Telecommunications Room Standard Premise Distribution**

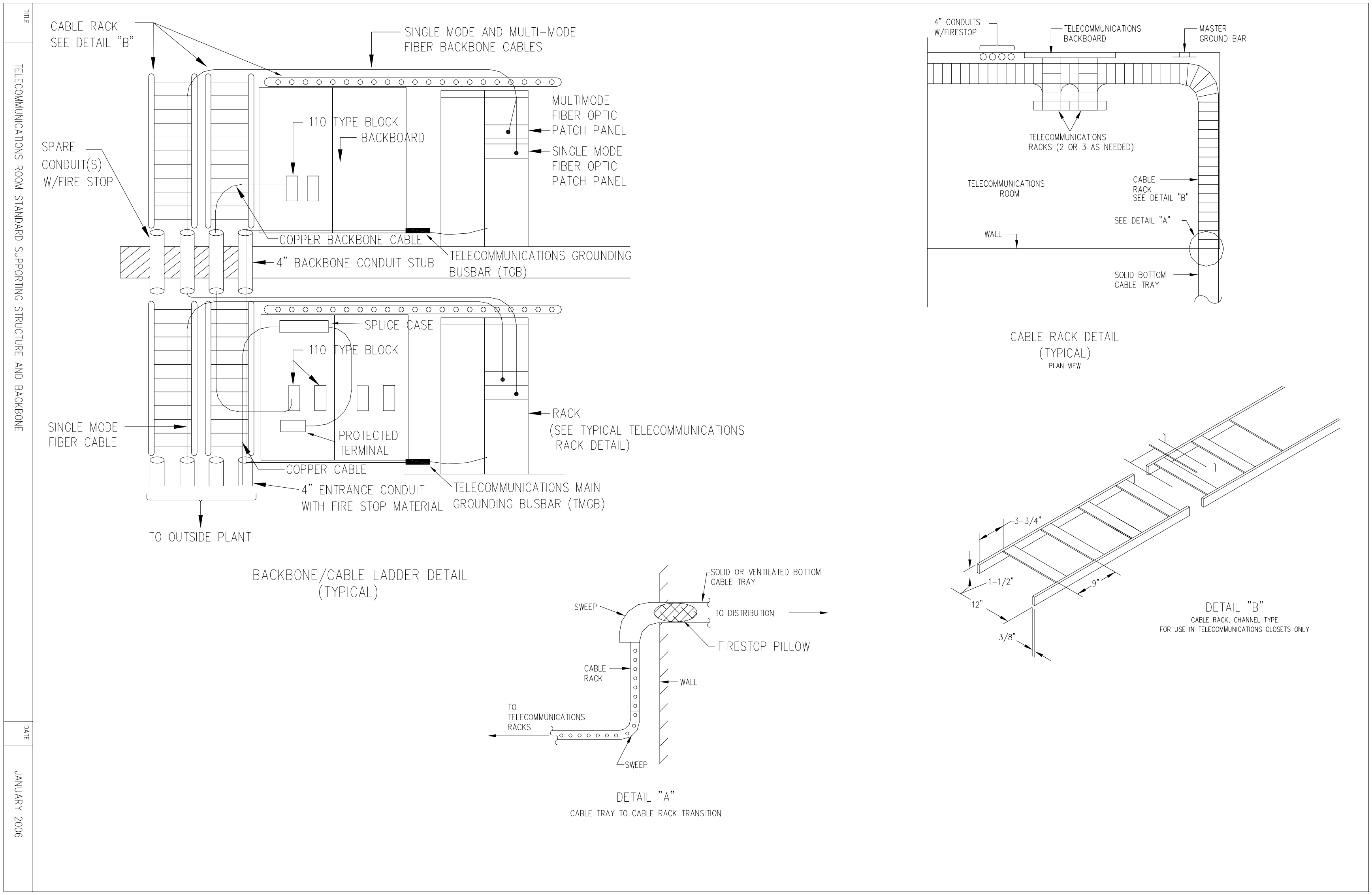



**Figure B-4. Telecommunications Room Standard Supporting Structure and Riser**

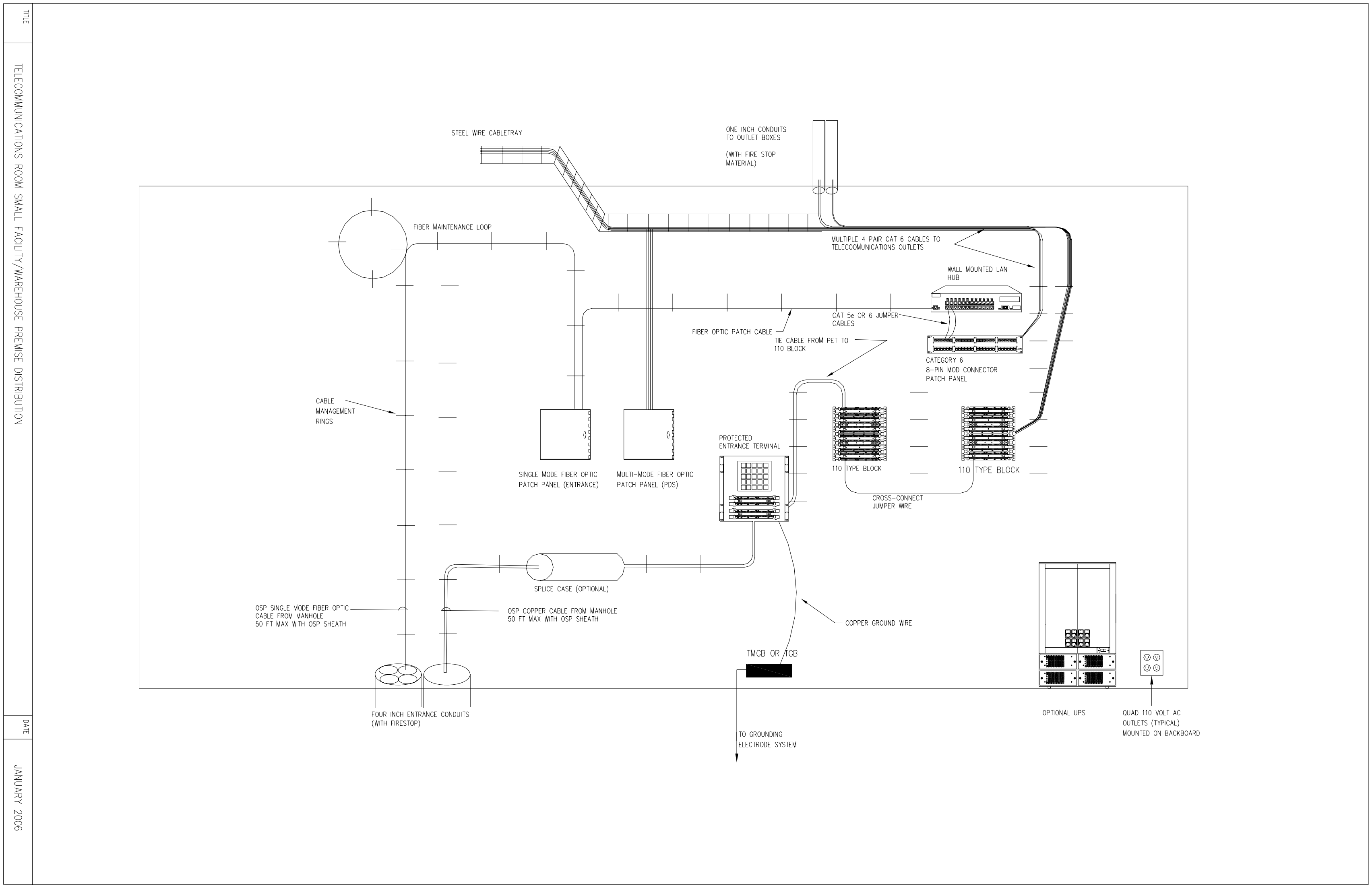



**Figure B-5. Telecommunications Room Small Facility/Warehouse**

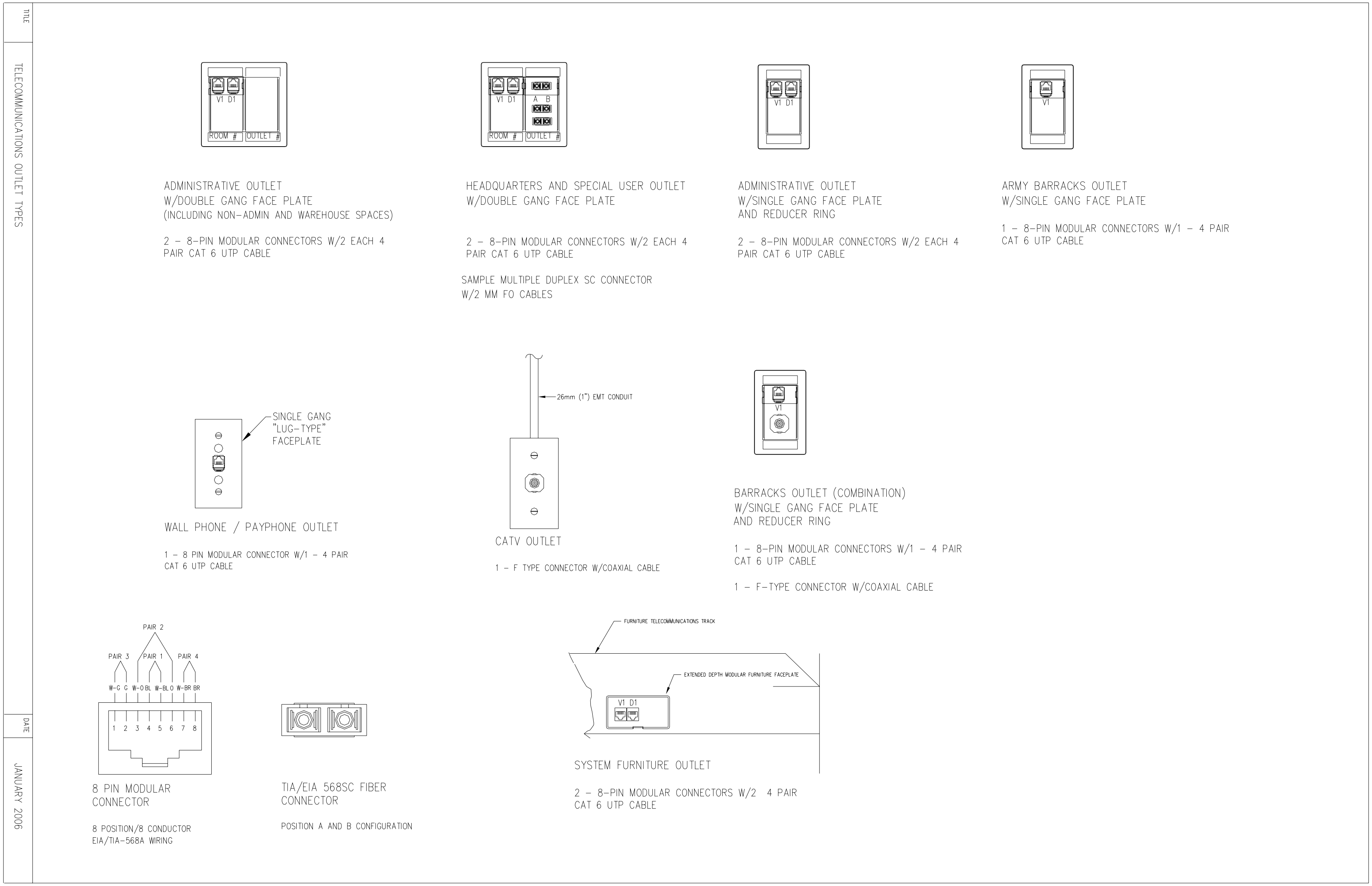



**Figure B-6. Telecommunications Outlet Types**

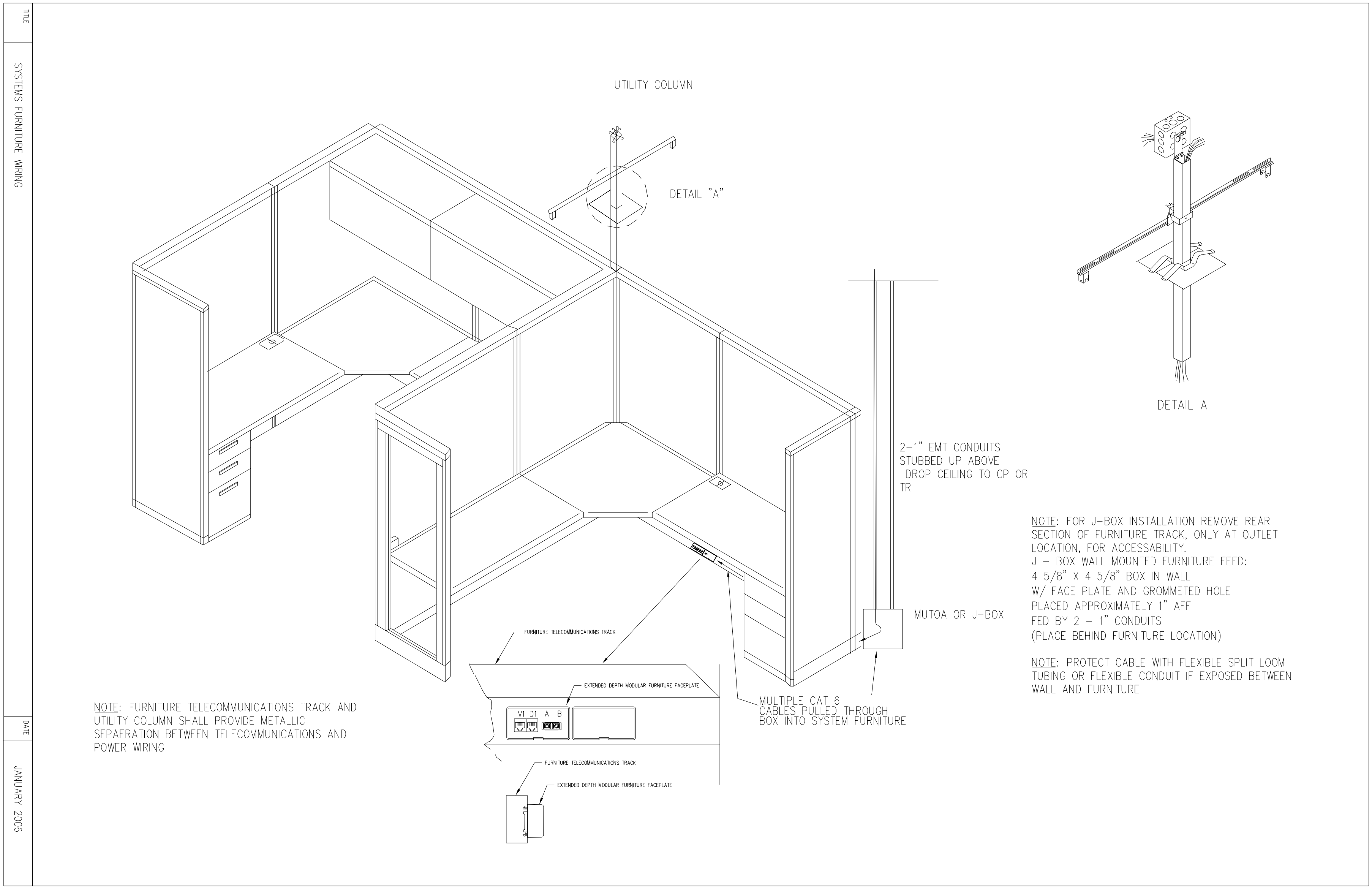



**Figure B-7. Systems Furniture Wiring**

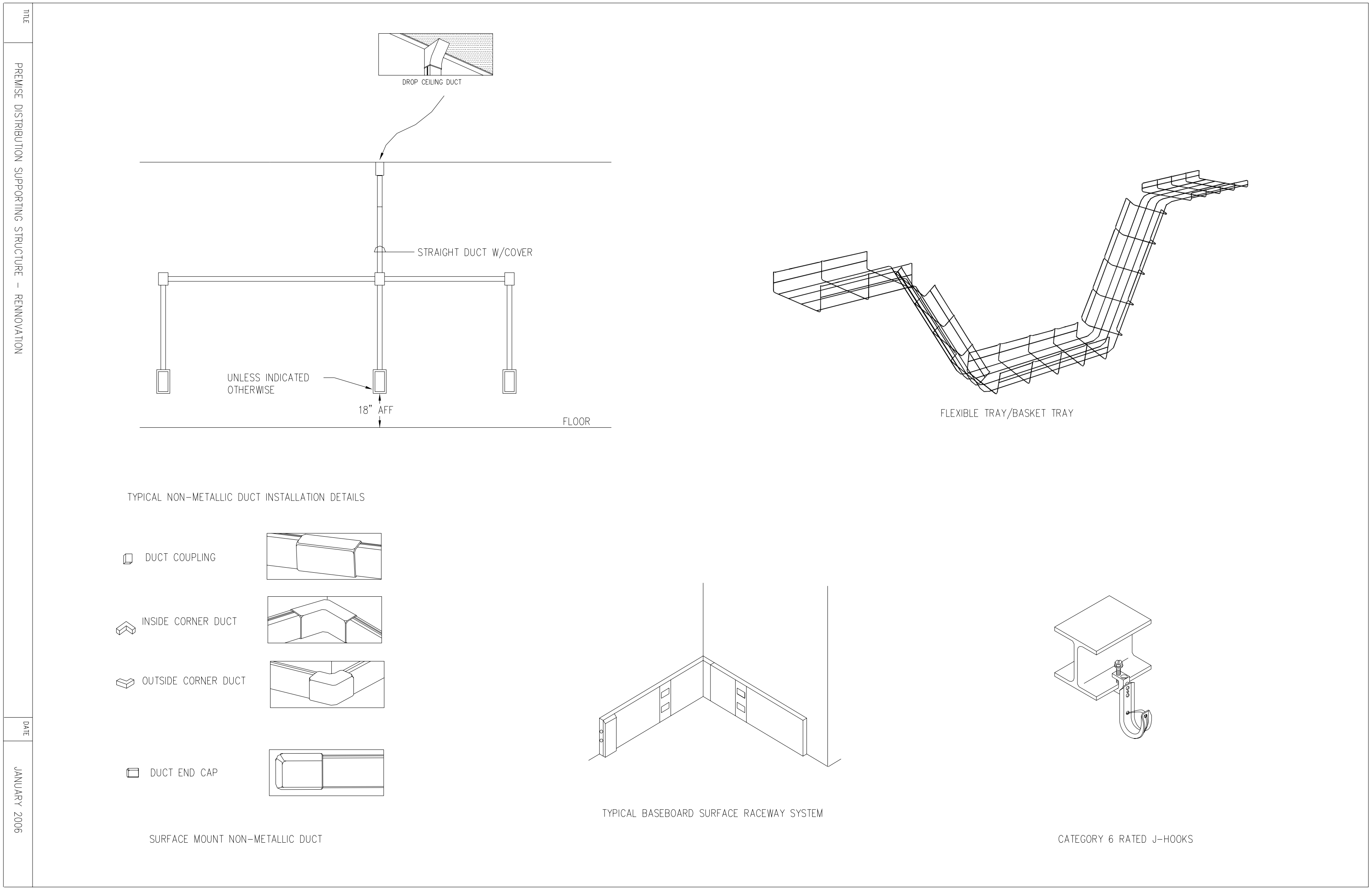



**Figure B-8. Premise Distribution Supporting Structure - Renovations**

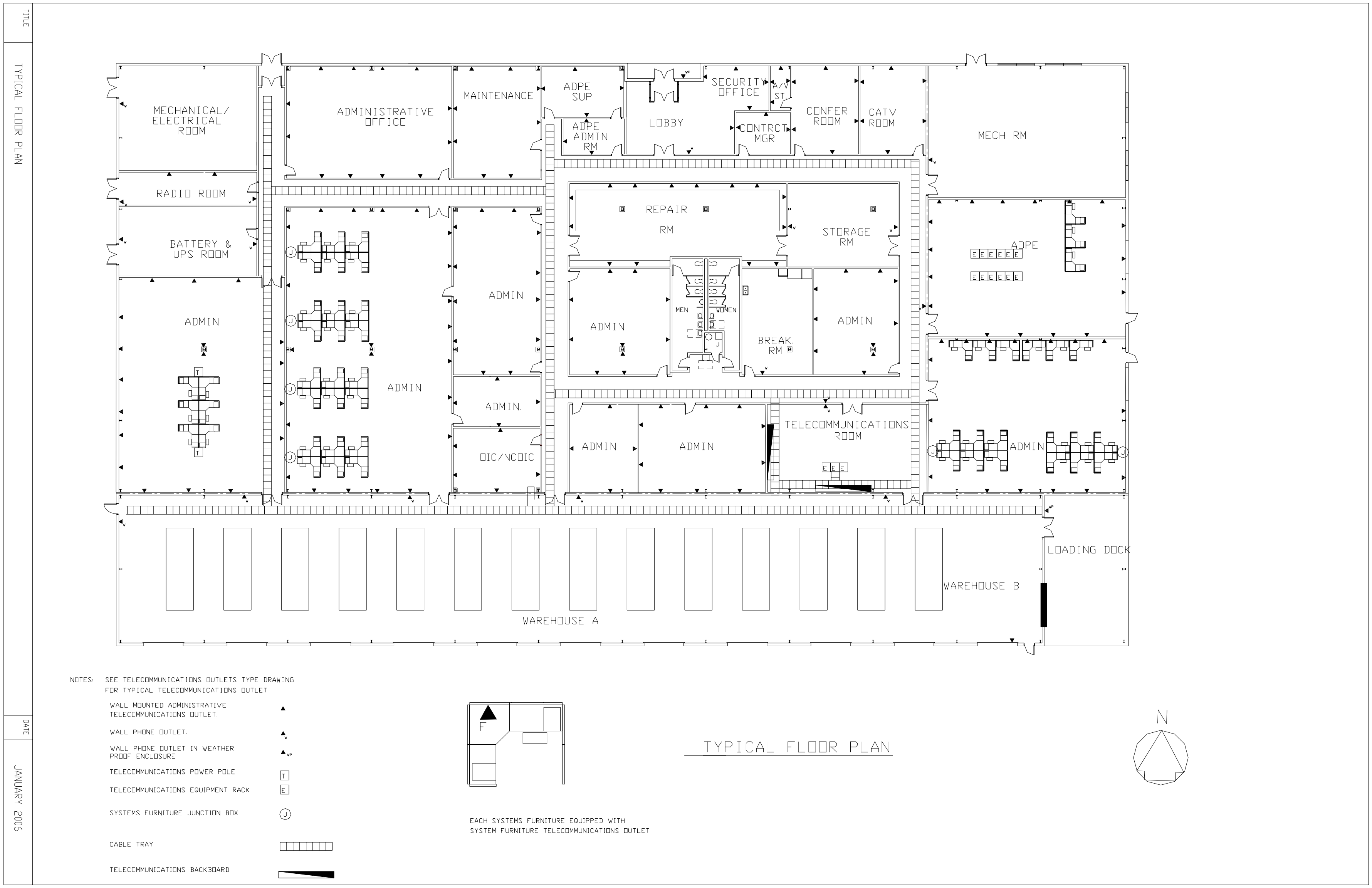



**Figure B-9. Typical Floor Plan**

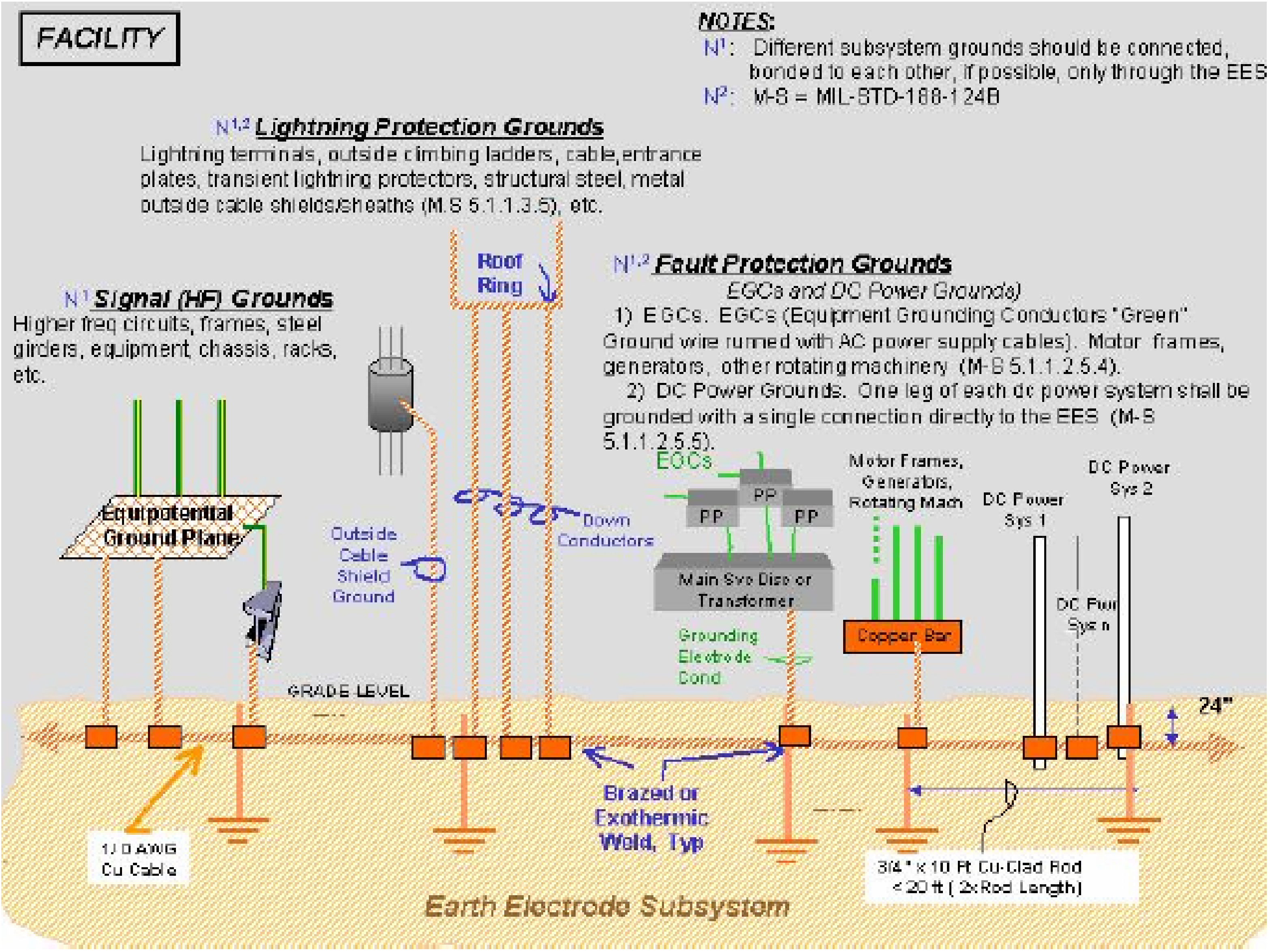



**Figure B-10. Grounding System**

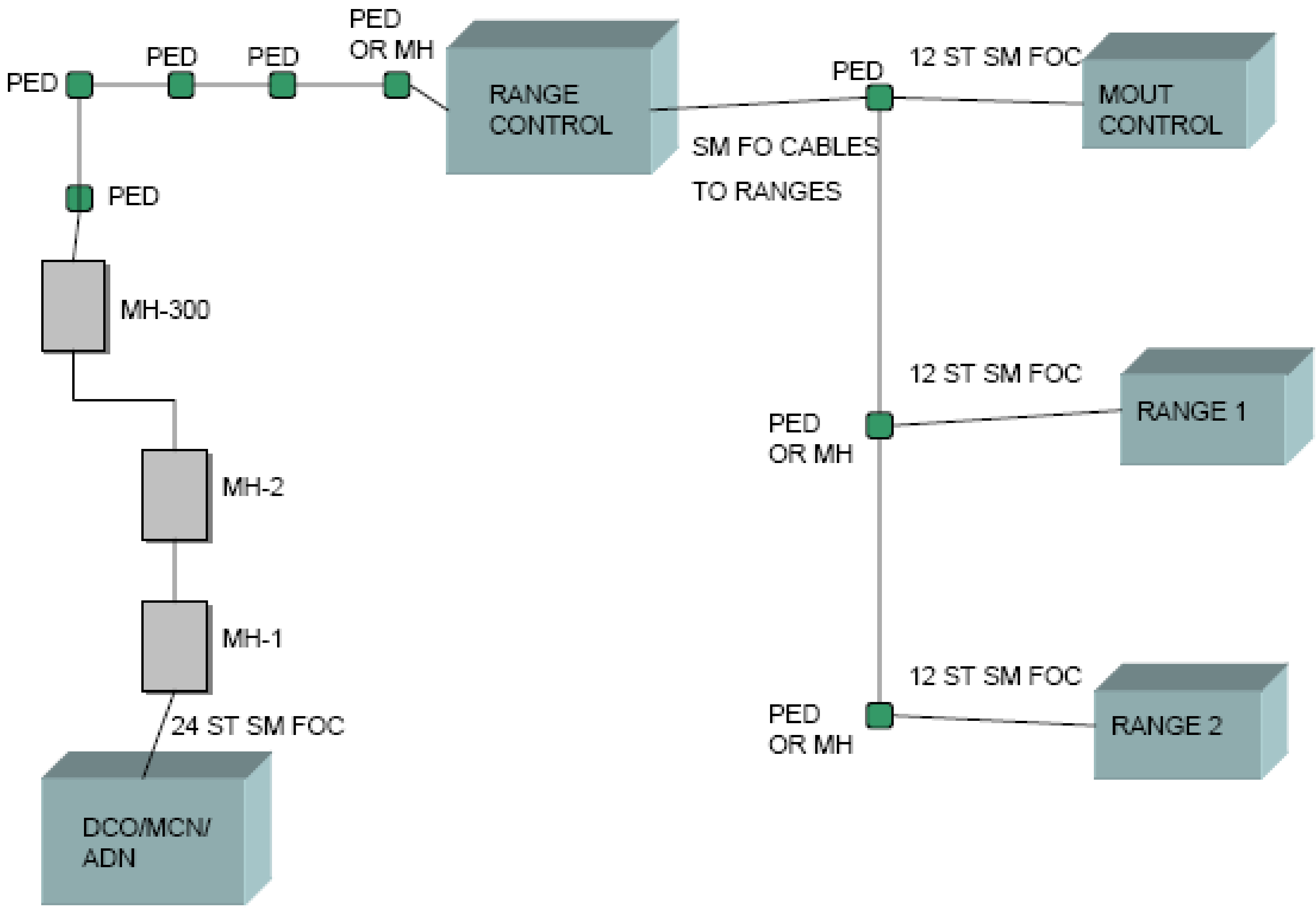



**Figure B-11. Range Design**

# APPENDIX C. NORTH AMERICA AND EUROPEAN DRAWINGS

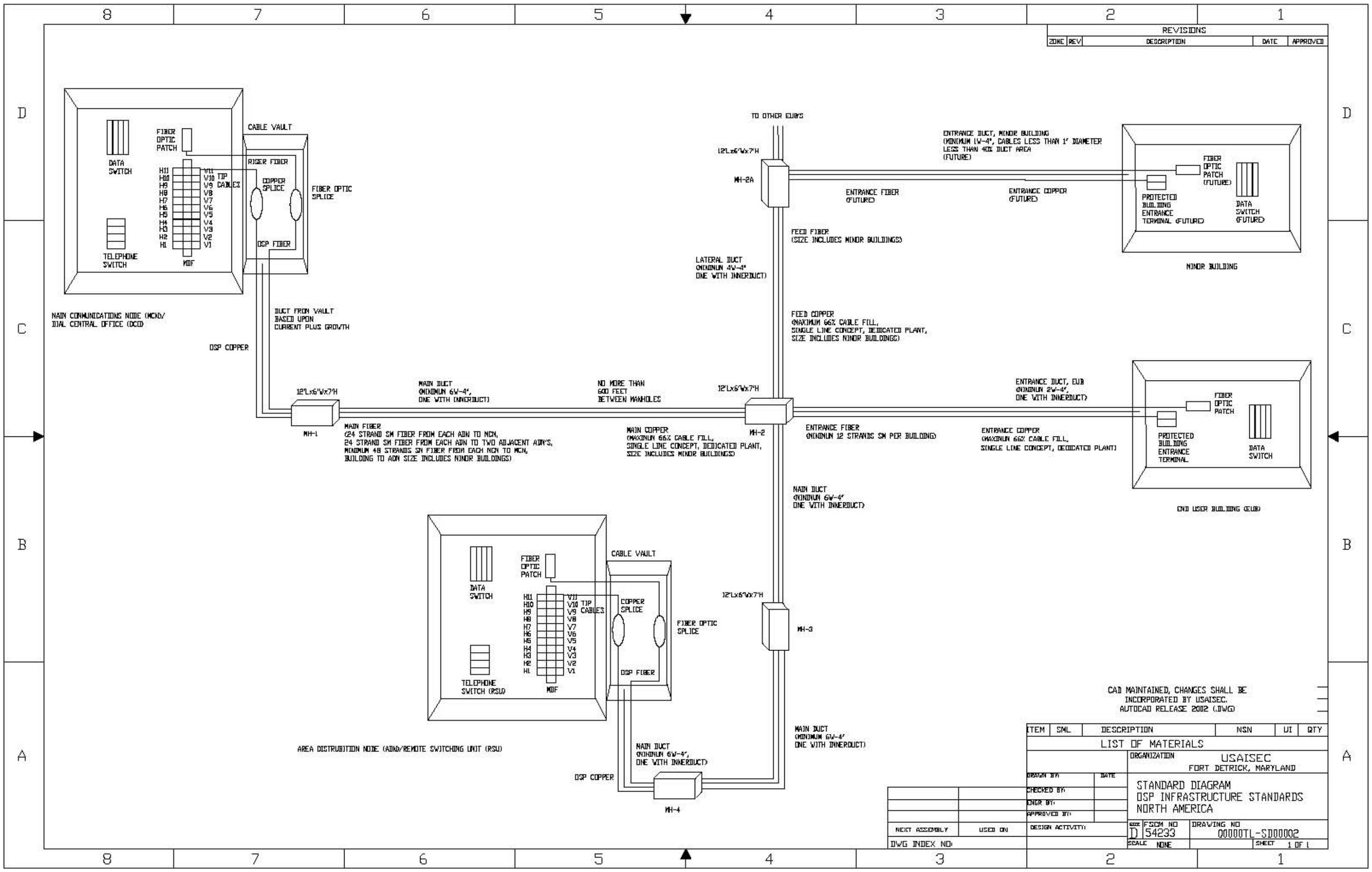



**Figure C-1. OSP Infrastructure Standards – North America**

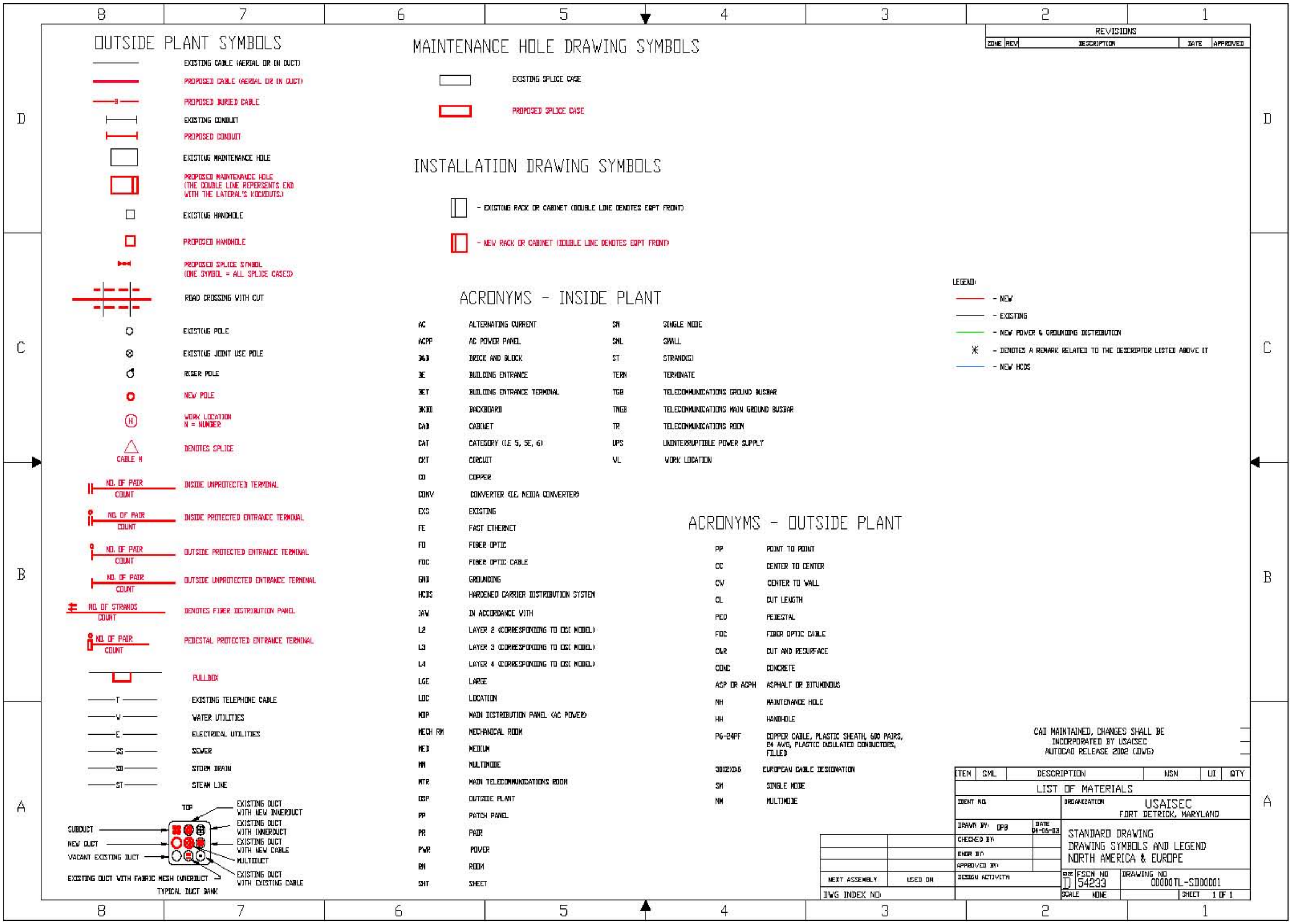



**Figure C-2.  Drawing Symbols – North America and Europe**

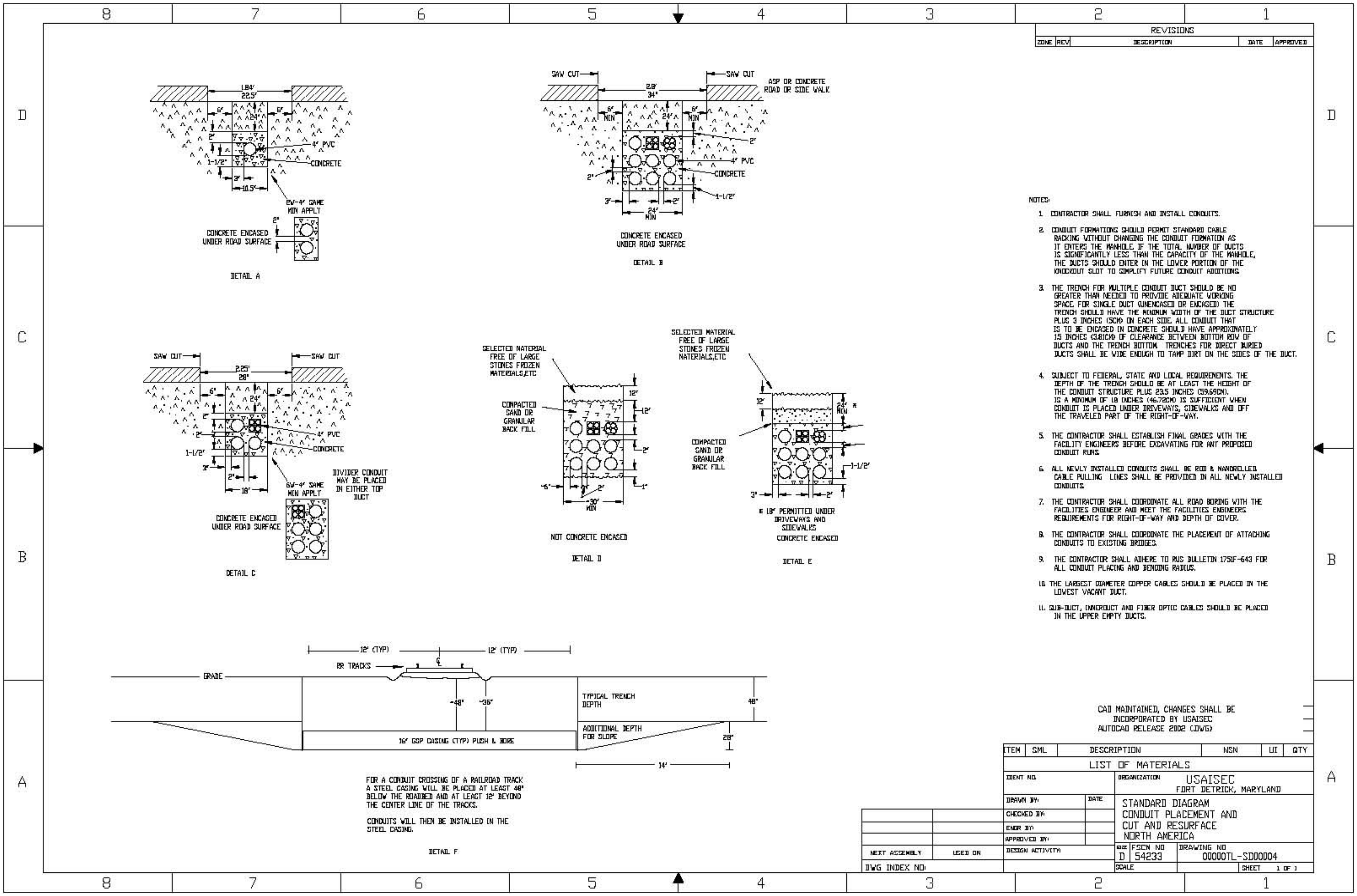
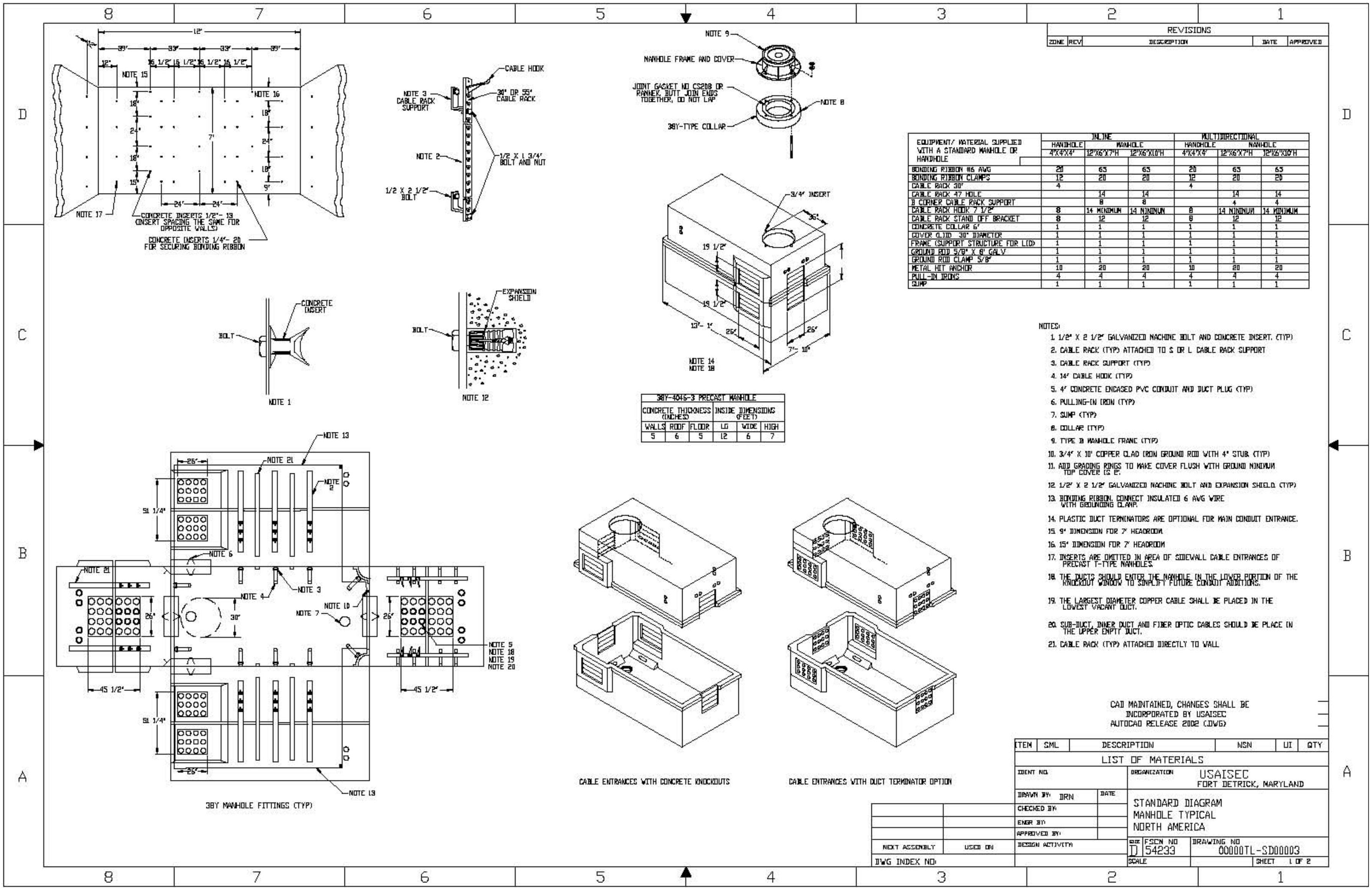



**Figure C-3. Conduit Placement/Cut and Resurface – North America**




| EQUIPMENT/ MATERIAL SUPPLIED WITH A STANDARD MANHOLE OR HANDHOLE | INLINE | | | MULTIDIRECTIONAL | | |
|---|---|---|---|---|---|---|
| | HANDHOLE | MANHOLE | | HANDHOLE | MANHOLE | |
| | 4'X4'X4' | 12'X6'X7'H | 12'X6'X10'H | 4'X4'X4' | 12'X6'X7'H | 12'X6'X10'H |
| BONDING RIBBON #6 AWG | 20 | 65 | 65 | 20 | 65 | 65 |
| BONDING RIBBON CLAMPS | 12 | 20 | 20 | 12 | 20 | 20 |
| CABLE RACK 30" | 4 | | | 4 | | |
| CABLE RACK 47 HOLE | | 14 | 14 | | 14 | 14 |
| B CORNER CABLE RACK SUPPORT | | 8 | 8 | | 4 | 4 |
| CABLE RACK HOOK 7 1/2" | 8 | 14 MINIMUM | 14 MINIMUM | 8 | 14 MINIMUM | 14 MINIMUM |
| CABLE RACK STAND OFF BRACKET | 8 | 12 | 12 | 8 | 12 | 12 |
| CONCRETE COLLAR 6" | 1 | 1 | 1 | 1 | 1 | 1 |
| COVER (LID) 30" DIAMETER | 1 | 1 | 1 | 1 | 1 | 1 |
| FRAME (SUPPORT STRUCTURE FOR LID) | 1 | 1 | 1 | 1 | 1 | 1 |
| GROUND ROD 5/8" X 8' GALV | 1 | 1 | 1 | 1 | 1 | 1 |
| GROUND ROD CLAMP 5/8" | 1 | 1 | 1 | 1 | 1 | 1 |
| METAL HIT ANCHOR | 10 | 20 | 20 | 10 | 20 | 20 |
| PULL-IN IRONS | 4 | 4 | 4 | 4 | 4 | 4 |
| SUMP | 1 | 1 | 1 | 1 | 1 | 1 |

**Figure C-4. Typical Maintenance Hole – North America (1 of 2)**

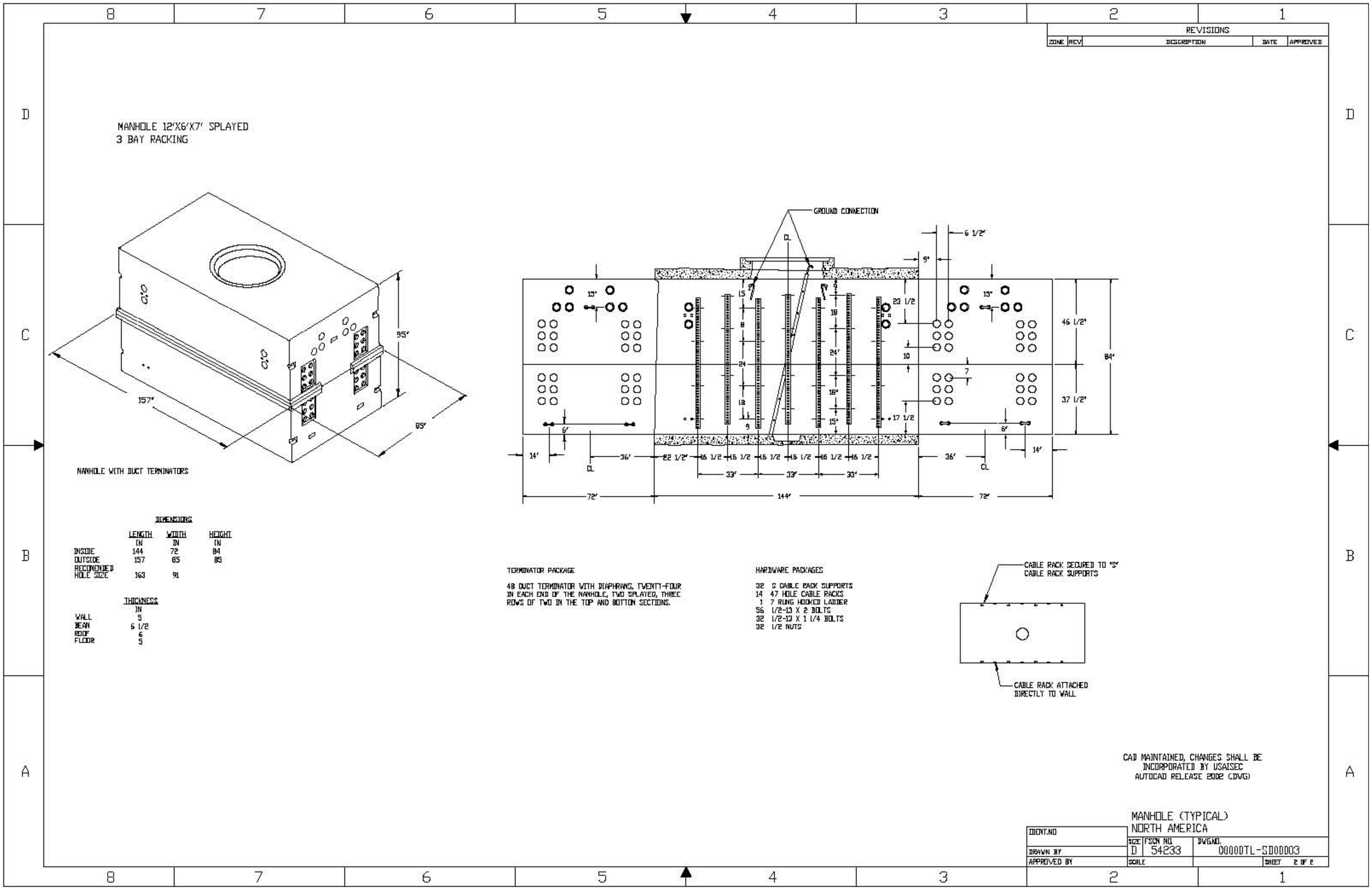



**Figure C-5. Typical Maintenance Hole – North America (2 of 2)**

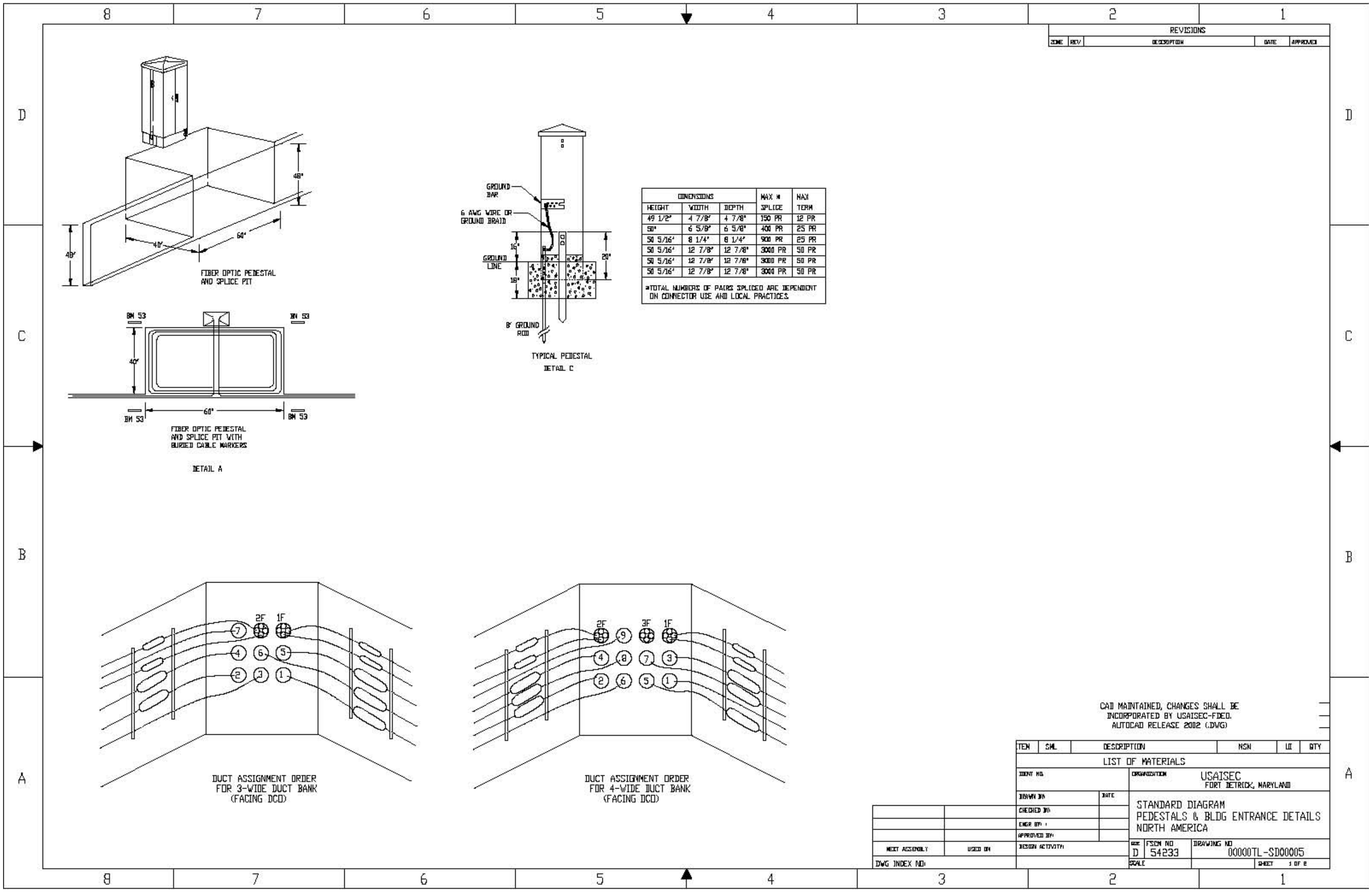



**Figure C-6. Pedestals and Building Entrance Details – North America (1 of 2)**

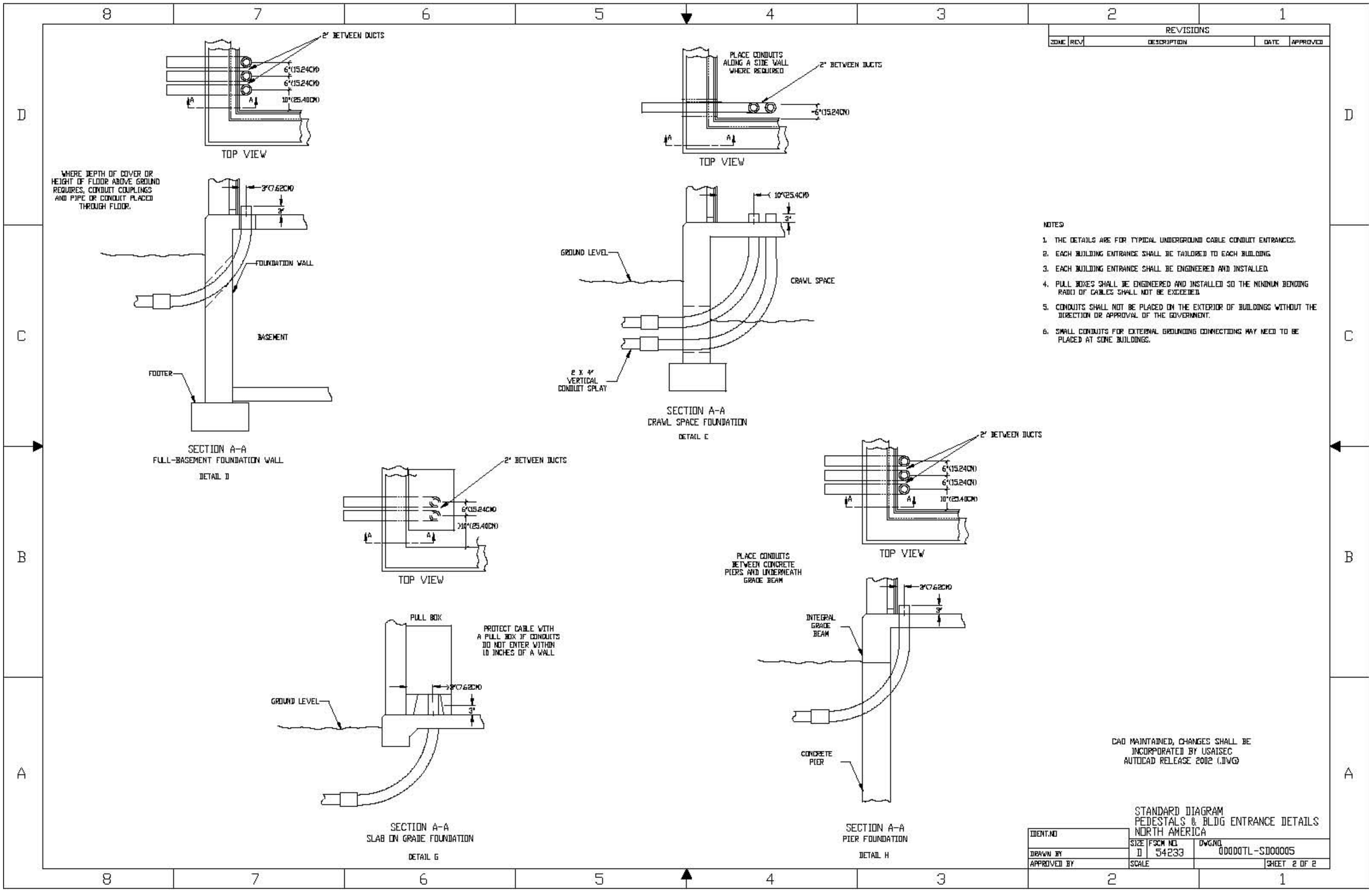



**Figure C-7. Pedestals and Building Entrance Details – North America (2 of 2)**

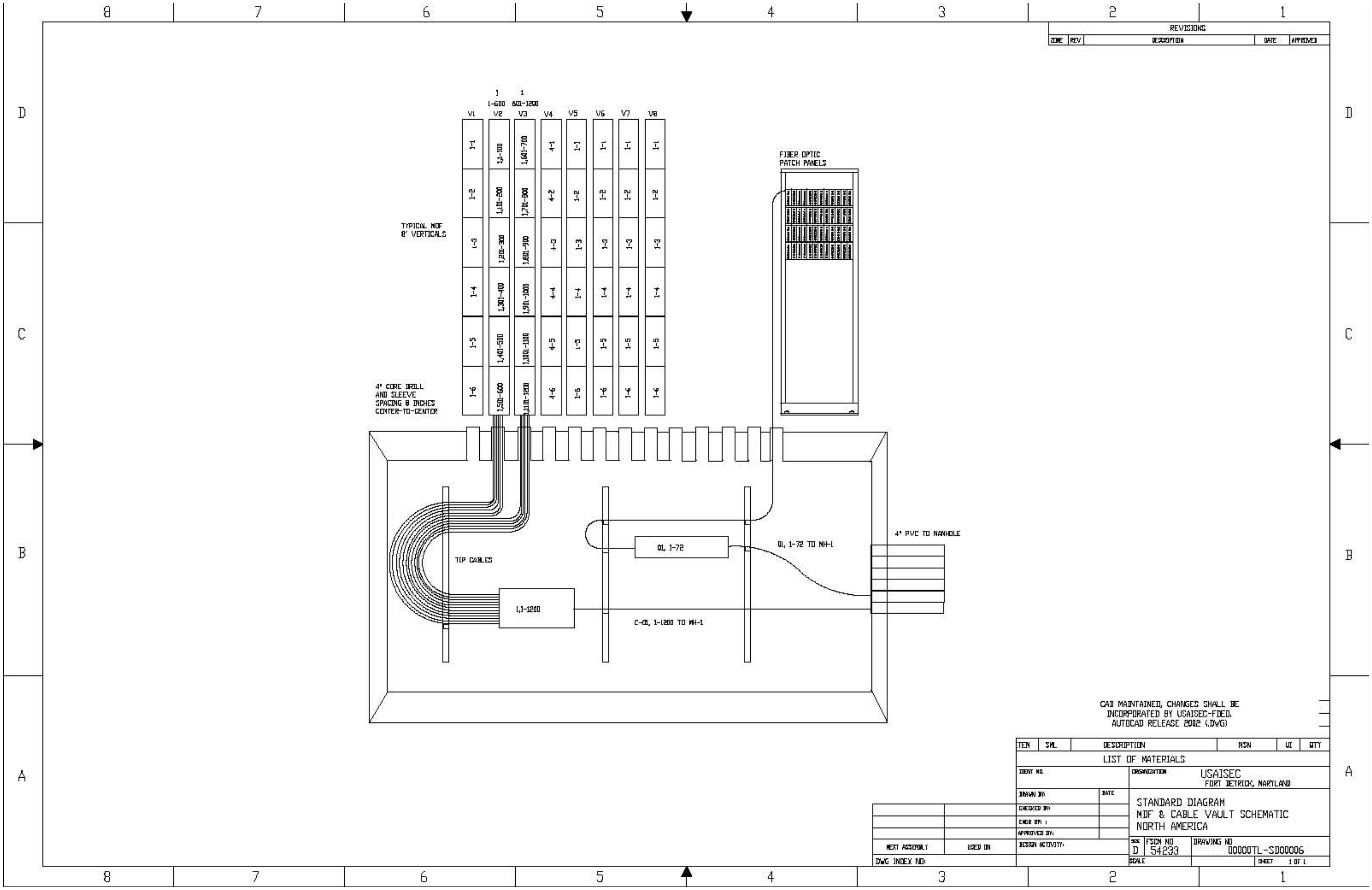



Figure C-8. MDF and Cable Vault Schematic – North America

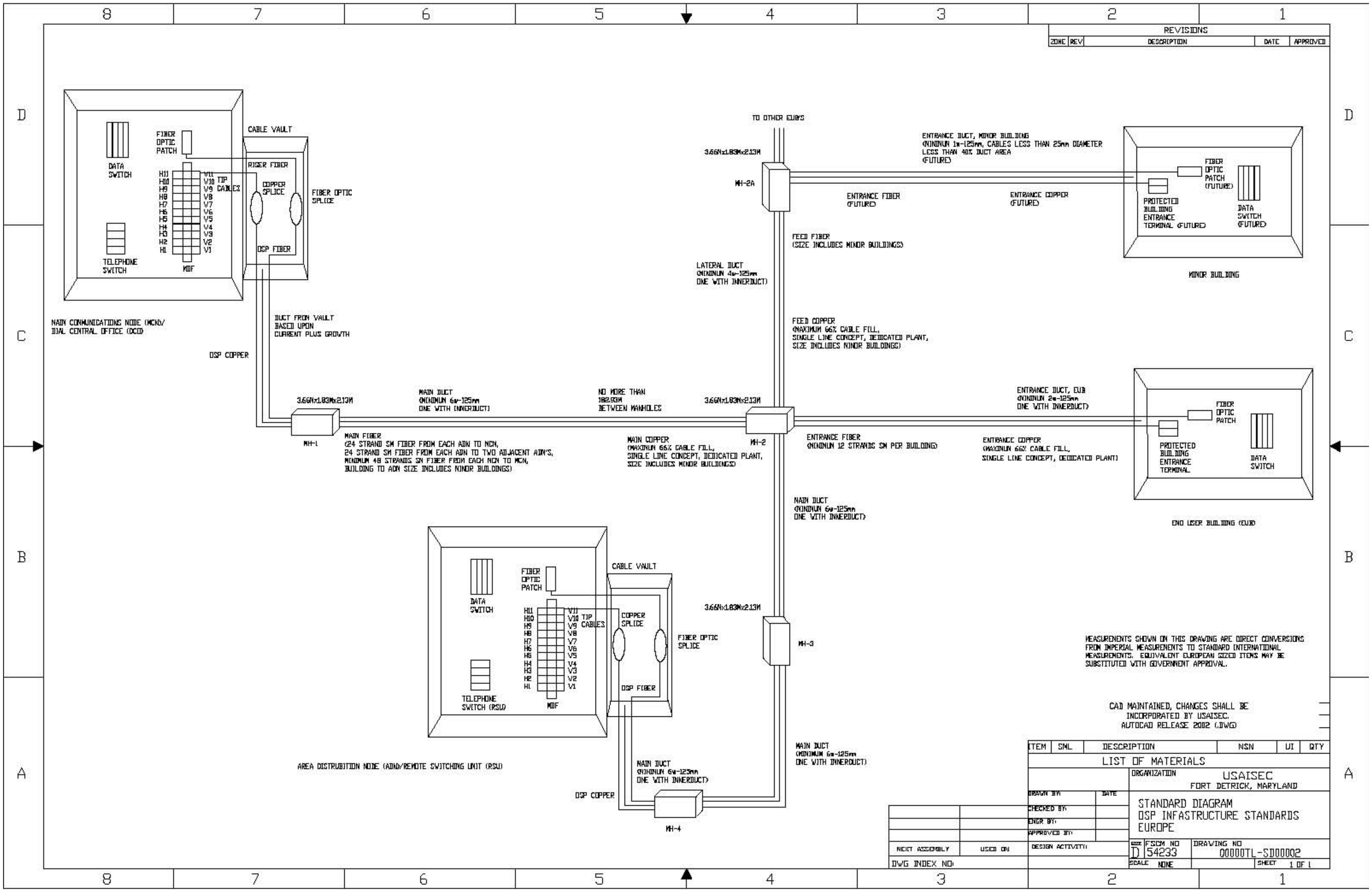



**Figure C-9. OSP Infrastructure Standards – Europe**

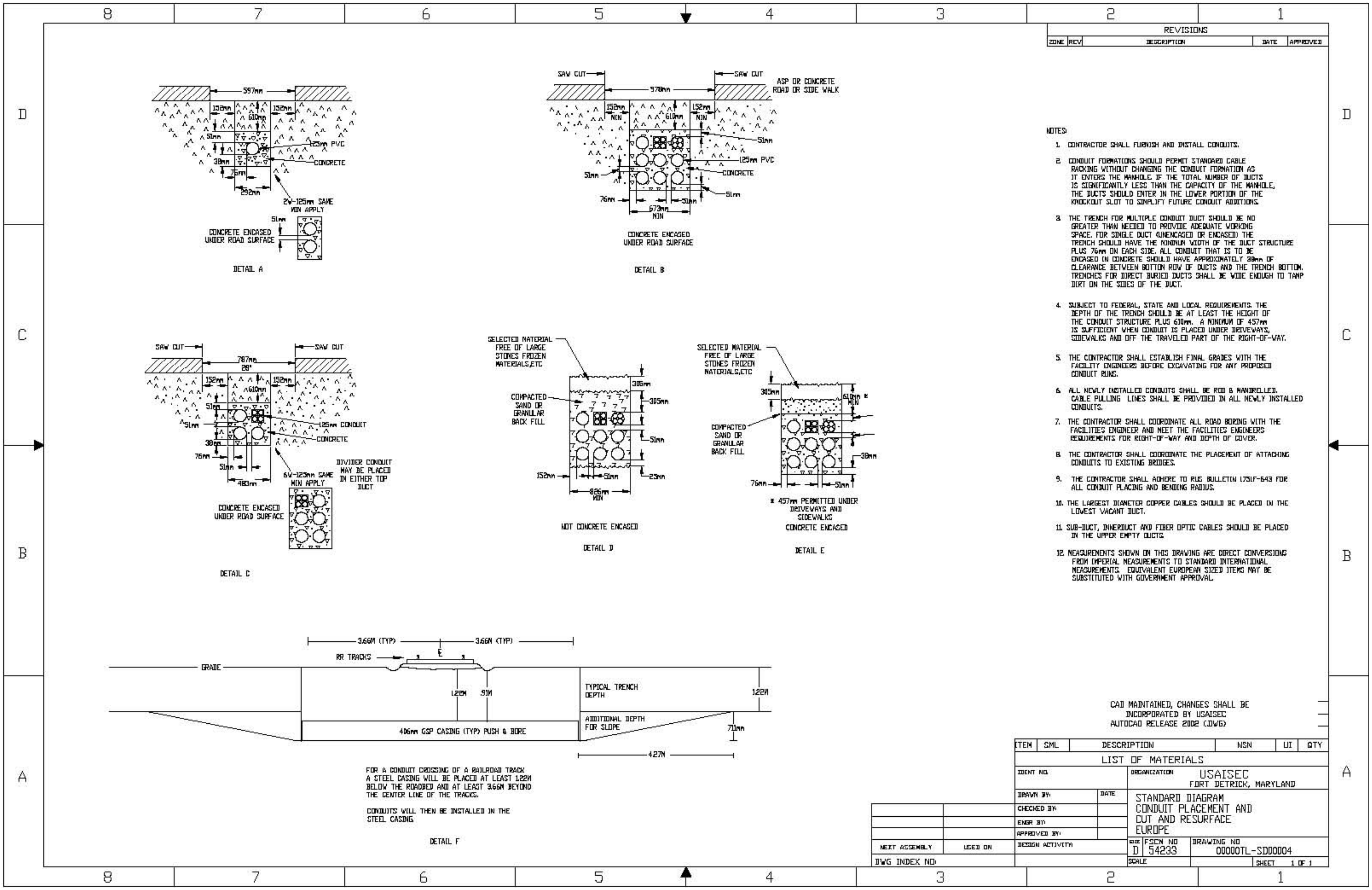



**Figure C-10. Conduit Placement/Cut and Resurface – Europe**

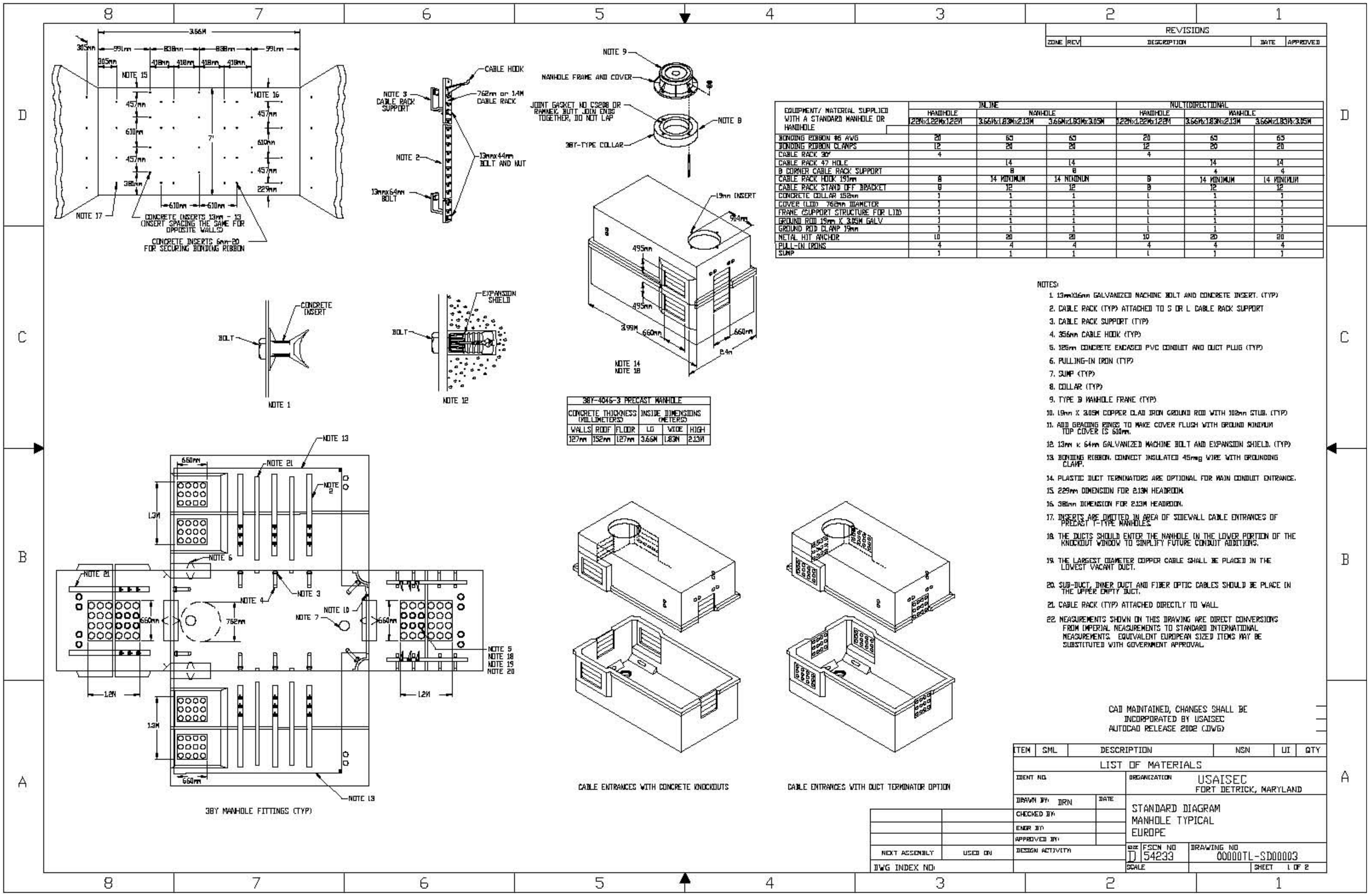
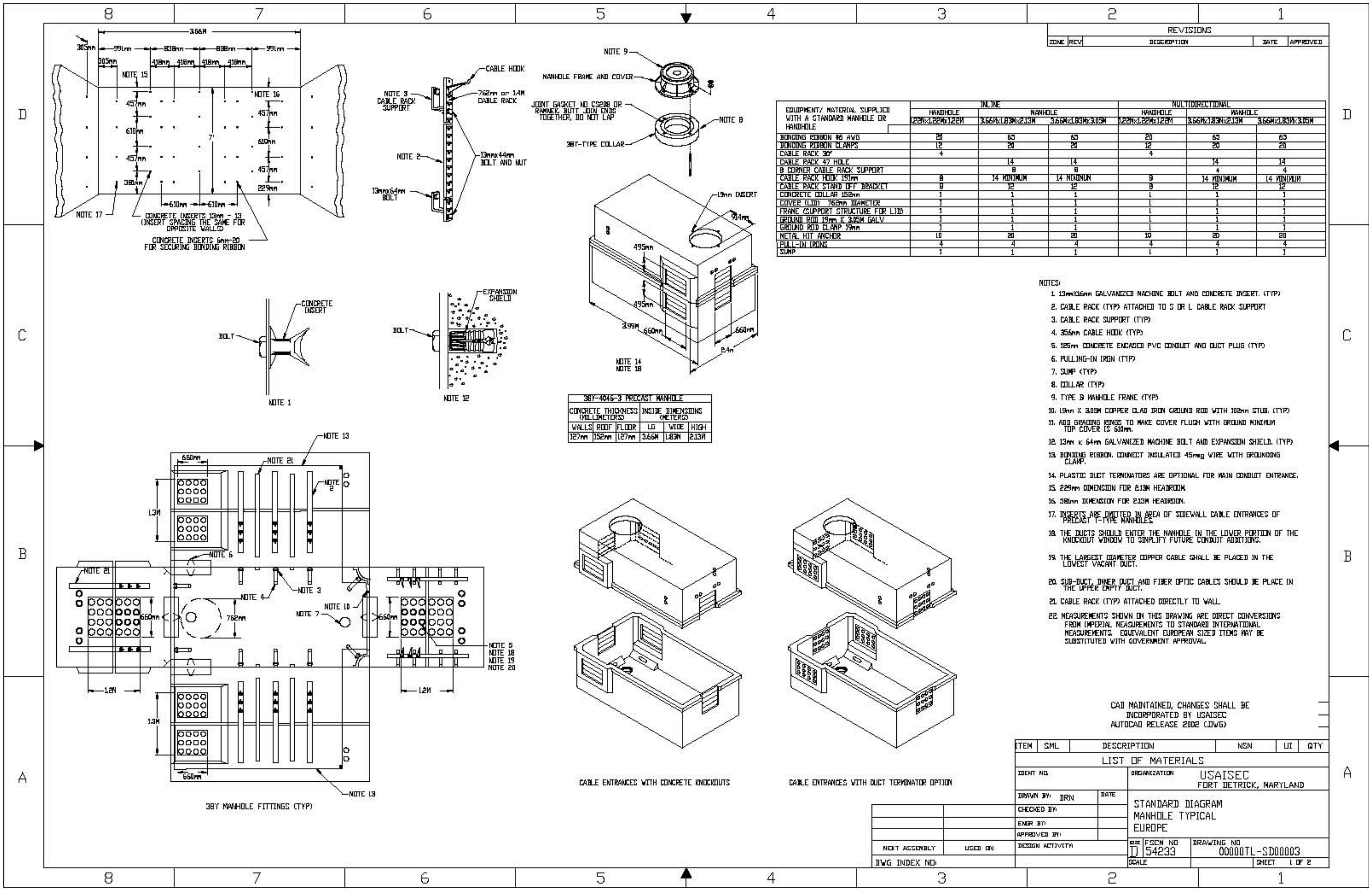



**Figure C-11. Typical Maintenance Hole – Europe (1 of 2)**

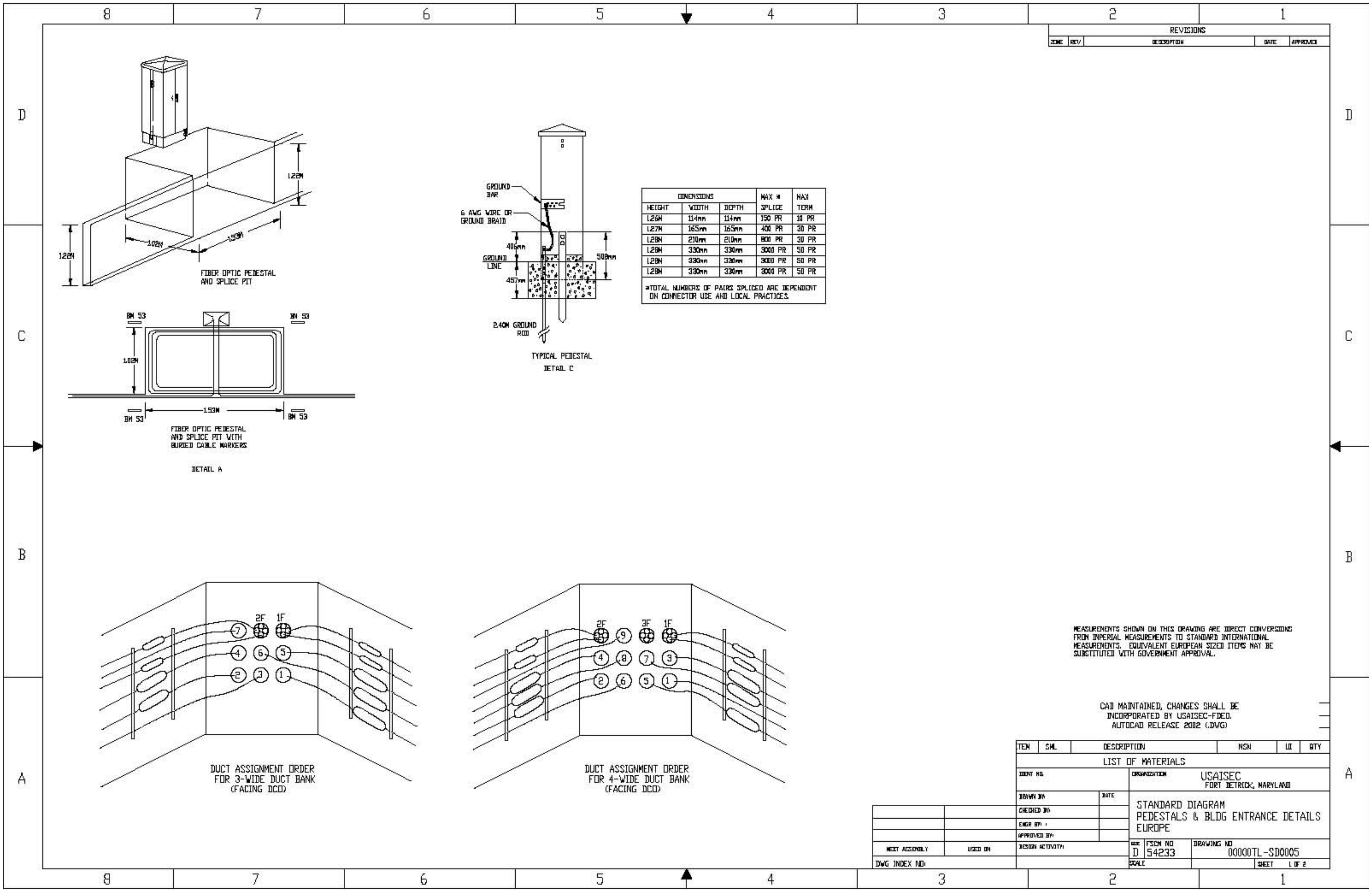



| EQUIPMENT/ MATERIAL SUPPLIED WITH A STANDARD MANHOLE OR HANDHOLE | INLINE HANDHOLE 1.22Mx1.22Mx1.22M | INLINE MANHOLE 3.66Mx1.83Mx2.13M | INLINE MANHOLE 3.66Mx1.83Mx3.05M | MULTIDIRECTIONAL HANDHOLE 1.22Mx1.22Mx1.22M | MULTIDIRECTIONAL MANHOLE 3.66Mx1.83Mx2.13M | MULTIDIRECTIONAL MANHOLE 3.66Mx1.83Mx3.05M |
|---|---|---|---|---|---|---|
| BONDING RIBBON #6 AWG | 20 | 65 | 65 | 20 | 65 | 65 |
| BONDING RIBBON CLAMPS | 12 | 20 | 20 | 12 | 20 | 20 |
| CABLE RACK 30" | 4 | | | 4 | | |
| CABLE RACK 47 HOLE | | 14 | 14 | | 14 | 14 |
| B CORNER CABLE RACK SUPPORT | | 8 | 8 | | 4 | 4 |
| CABLE RACK HOOK 191mm | 8 | 14 MINIMUM | 14 MINIMUN | 8 | 14 MINIMUM | 14 MINIMUM |
| CABLE RACK STAND OFF BRACKET | 8 | 12 | 12 | 8 | 12 | 12 |
| CONCRETE COLLAR 152mm | 1 | 1 | 1 | 1 | 1 | 1 |
| COVER (LID) 762mm DIAMETER | 1 | 1 | 1 | 1 | 1 | 1 |
| FRAME (SUPPORT STRUCTURE FOR LID) | 1 | 1 | 1 | 1 | 1 | 1 |
| GROUND ROD 19mm X 3.05M GALV | 1 | 1 | 1 | 1 | 1 | 1 |
| GROUND ROD CLAMP 19mm | 1 | 1 | 1 | 1 | 1 | 1 |
| METAL HIT ANCHOR | 10 | 20 | 20 | 10 | 20 | 20 |
| PULL-IN IRONS | 4 | 4 | 4 | 4 | 4 | 4 |
| SUMP | 1 | 1 | 1 | 1 | 1 | 1 |

38Y-4046-3 PRECAST MANHOLE

| CONCRETE THICKNESS (MILLIMETERS) WALLS | ROOF | FLOOR | INSIDE DIMENSIONS (METERS) LG | WIDE | HIGH |
|---|---|---|---|---|---|
| 127mm | 152mm | 127mm | 3.66M | 1.83M | 2.13M |

**Figure C-12. Typical Maintenance Hole – Europe (2 of 2)**




| DIMENSIONS | | | MAX * | MAX |
|---|---|---|---|---|
| HEIGHT | WIDTH | DEPTH | SPLICE | TERM |
| 1.26M | 114mm | 114mm | 150 PR | 10 PR |
| 1.27M | 165mm | 165mm | 400 PR | 30 PR |
| 1.28M | 210mm | 210mm | 800 PR | 30 PR |
| 1.26M | 330mm | 330mm | 3000 PR | 50 PR |
| 1.28M | 330mm | 330mm | 3000 PR | 50 PR |
| 1.28M | 330mm | 330mm | 3000 PR | 50 PR |

*TOTAL NUMBERS OF PAIRS SPLICED ARE DEPENDENT ON CONNECTOR USE AND LOCAL PRACTICES.

**Figure C-13. Pedestals and Building Entrance Details – Europe (1 of 2)**

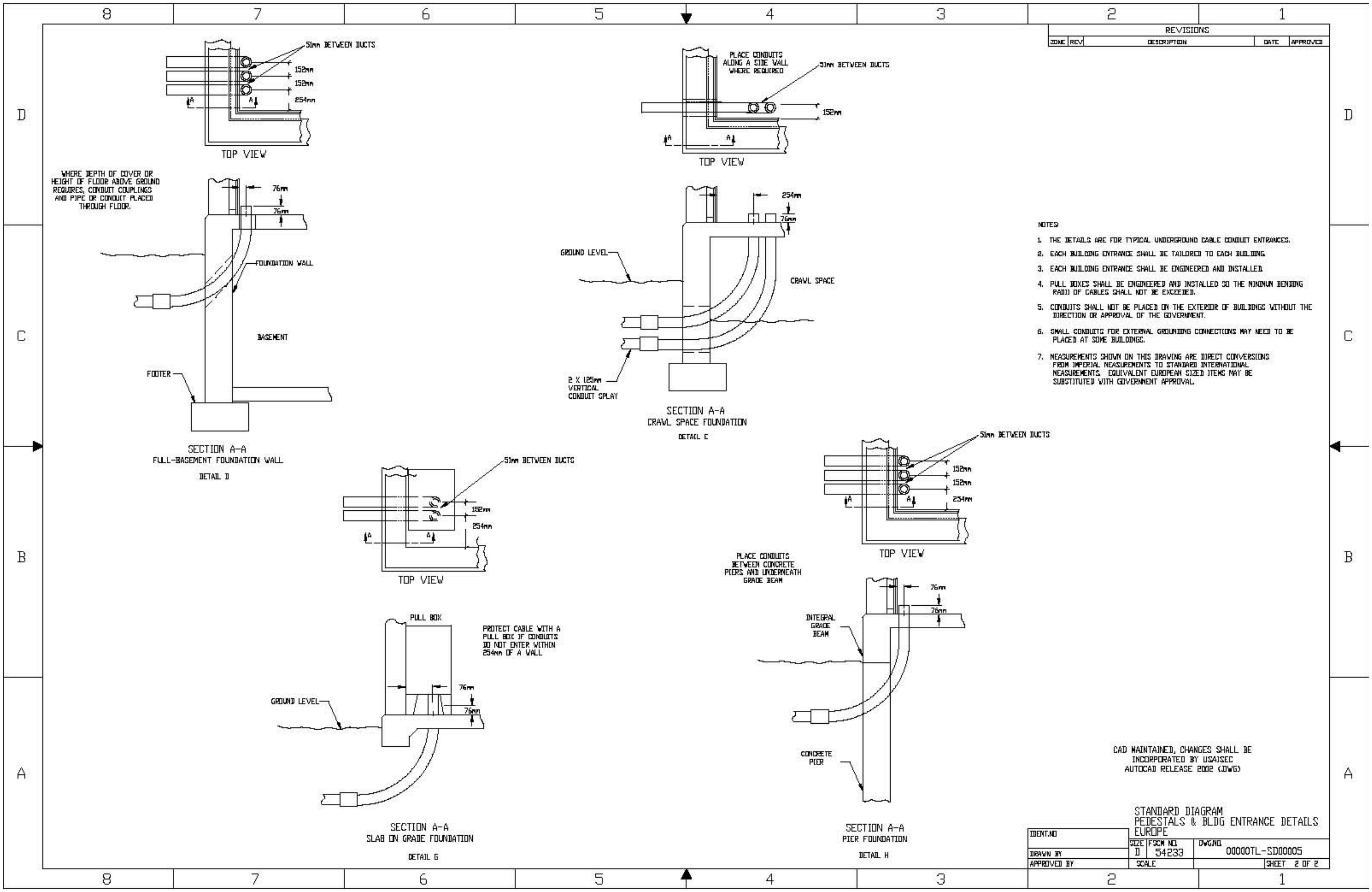



**Figure C-14. Pedestals and Building Entrance Details – Europe (2 of 2)**

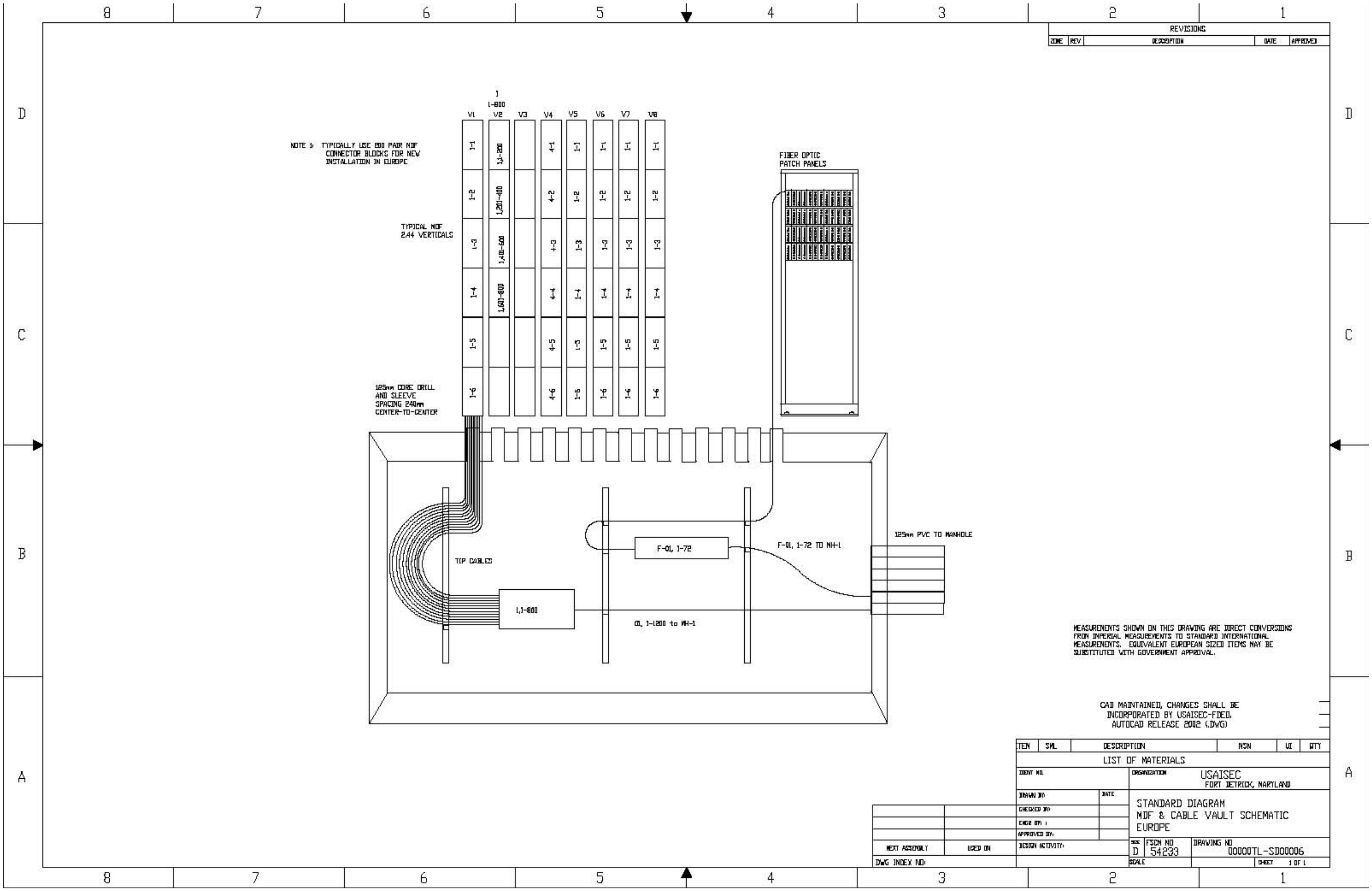



**Figure C-15. MDF and Cable Vault Schematic – Europe**

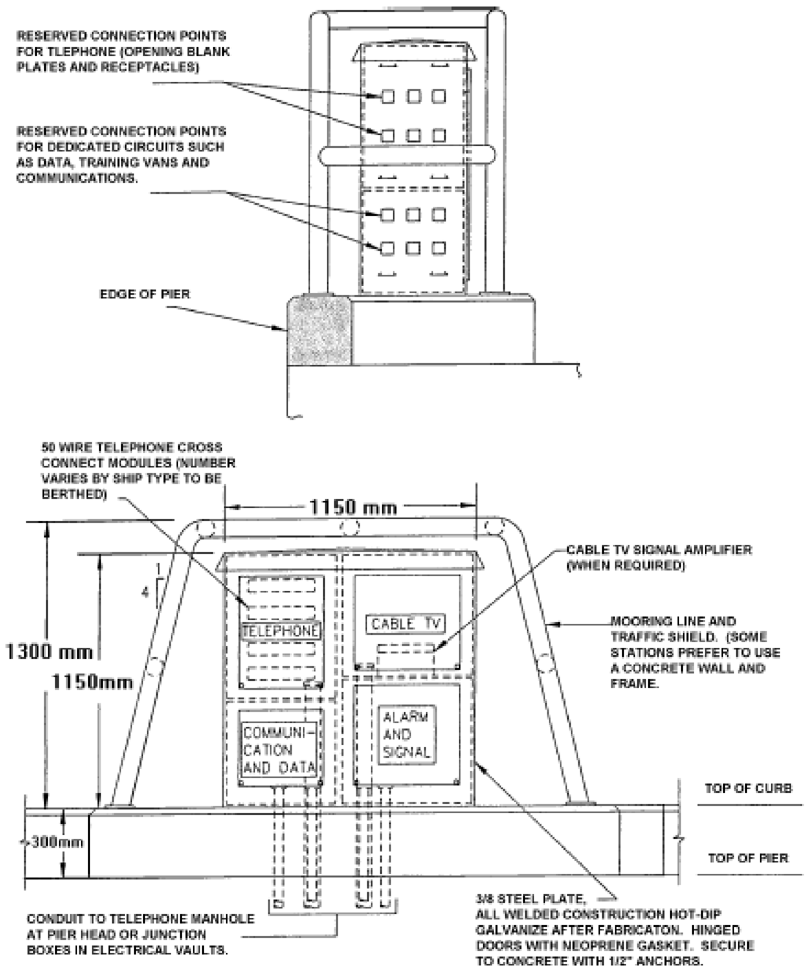



**Figure C-16. Illustration of Pier Igloo Construction**

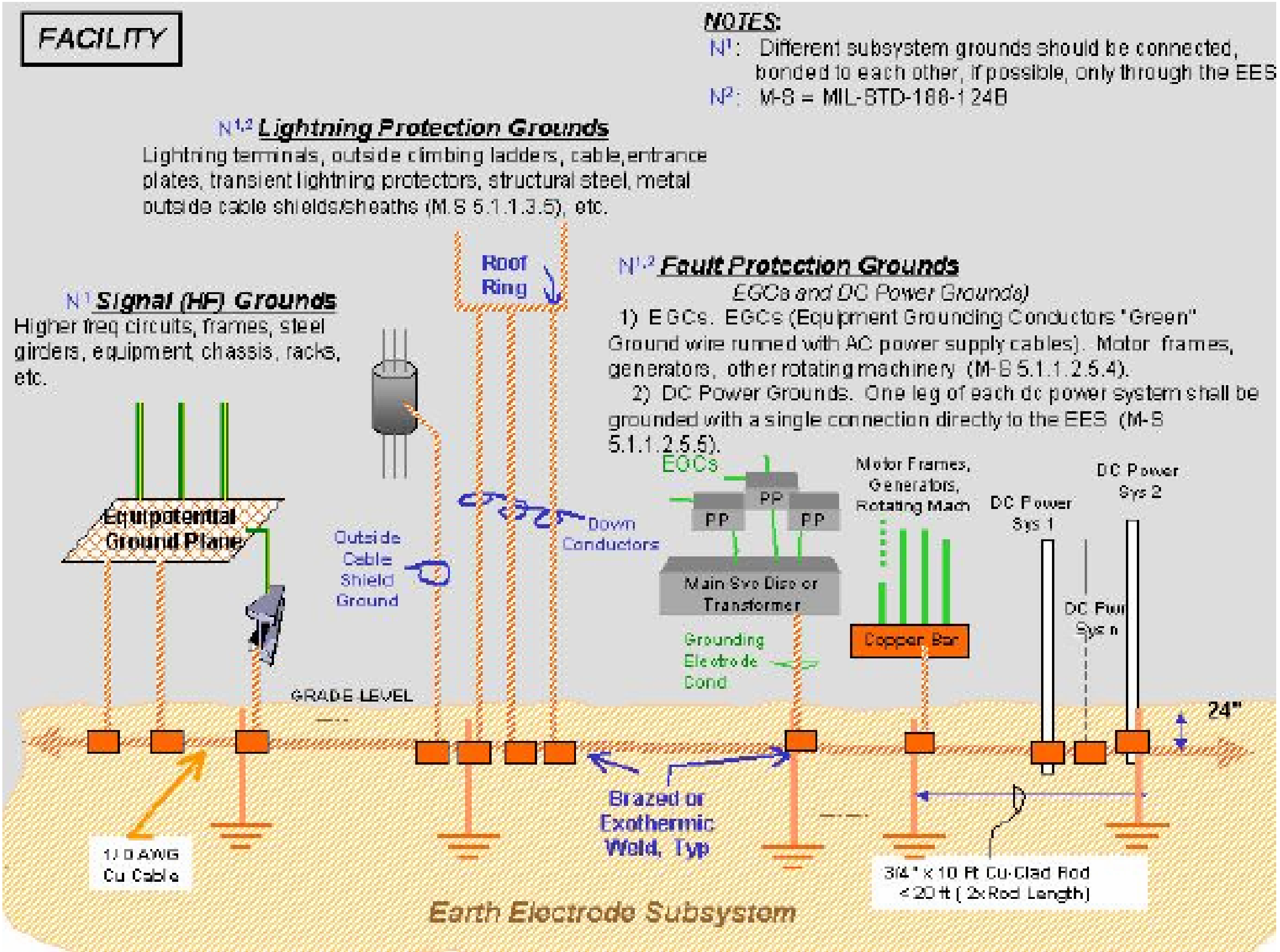



**Figure C-17. Grounding System**

# APPENDIX D. REFERENCES

1. ANSI/TIA/EIA-568-B.1 Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements

2. ANSI/TIA/EIA-568-B.2 Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted Pair Cabling Components

3. ANSI/TIA/EIA-568-B.2 –1 Addendum 1 – Transmission Performance Specifications for 4-pair 100-ohm Category 6 Cabling

4. ANSI/TIA/EIA-568-B.2–4 Addendum 4 - Solderless Connection Reliability Requirements for Copper Connecting Hardware

5. ANSI/TIA/EIA-568-B.3 Commercial Building Telecommunications Cabling Standard, Part 3: Optical Fiber Cabling Components

6. ANSI/TIA/EIA-568-B.3-1 Addendum 1 –Additional Transmission Performance Specifications for 50/125 Optical Fiber Cables

7. ANSI/TIA/EIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces

8. ANSI/TIA/EIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant

9. ANSI/TIA/EIA-526-14A Measurement of Optical Power Loss of Installed Multimode Fiber Cable Plant

10. ANSI/TIA/EIA-606-A Administrative Standard for the Telecommunications Infrastructure of Commercial Buildings

11. ANSI-J-STD-607-A-2002, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, Telecommunications Industry Association (TIA), October 2002.

12. EN 50173:1996 Information Technology – Generic Cabling Systems

13. EN 50174-1:2001 Information Technology – Cabling Installation, Part 1: Specification and Quality Assurance

14. EN 50174-2:2001 Information Technology – Cabling Installation, Part 2: Installation Planning and Practices Inside Buildings

15. EN 50174-3:2002 DRAFT Information Technology – Cabling Installation, Part 3: Installation Planning and Practices Outside Buildings

16. ISO/IEC 11801:2002 Information Technology – Generic Cabling for Customer Premises

17. ISO/IEC 14763-1:1999 Information Technology – Implementation and Operation of Customer Premises Cabling, Part 1: Administration

18. ISO/IEC 14763-2:2000 Information Technology – Implementation and Operation of Customer Premises Cabling, Part 2: Planning and Installation

19. ISO/IEC 14763-3:2000 Information Technology – Implementation and Operation of Customer Premises Cabling, Part 3: Testing of Optical Fiber Cabling

20. NFPA 70, National Electrical Code, 2002 Edition, National Fire Protection Association, Inc., August 2001.

21. NFPA 780, Standard for the Installation of Lightning Protection Systems, latest issue

22. C2-2002, National Electrical Safety Code, 2002 Edition, Institute of Electrical and Electronics Engineers, Inc., August 2002.

23. MIL-STD-188-124B, Grounding, Bonding And Shielding for Common Long Haul/Tactical Communication Systems Including Ground Based Communications- Electronics Facilities and Equipments.

24. MIL-HDBK-419A, Grounding, Bonding, and Shielding For Electronic Equipments and Facilities.

25. UFC 1-300-01 Criteria Format Standard

26. UFC 3-580-10 Design: Navy And Marine Corps Intranet (NMCI) Standard Construction Practices Information System (IS)

27. UFGS-16710 09/2004, Structured Telecommunications Cabling and Pathway System.

## Outside Plant References

| Priority | Source | Identifier | Title | Source URL |
|---|---|---|---|---|
| 1 | Army | N/A | Site-Specific EDP | N/A |
| 2 | Army | N/A | Outside Plant Design and Performance Requirements (OSPDPR) | N/A |
| 3 | BICSI | CO-OSP, 2nd edition, 2001 | CO-OSP Design Manual / CD-ROM Set | https://www.bicsi.org |
| 4 | ASTM | ASTM D2239 | Standard Specification for PE Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter | http://www.astm.org |
| 4 | ASTM | ASTM D 2447 | Specification for PE Plastic Pipe, Schedule 40 and Schedule 80 Based on Controlled Outside Diameter | http://www.astm.org |
| 4 | ASTM | ASTM D3350 | Standard Specification for PE Plastic Pipe and Fittings Materials | http://www.astm.org |
| 4 | ASTM | ASTM A139 | Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over) | http://www.astm.org |
| 4 | ANSI | ANSI/TIA/EIA-568-B | Commercial Building Telecommunications Cabling Standards Set | http://global.ihs.com. |
| 4 | ANSI | ANSI/TIA/EIA-569-A-1-2000 | Addendum (ADD) 1 - Surface Raceways | http://global.ihs.com |
| 4 | ANSI | ANSI/TIA/EIA-569-A-98 | Commercial Building Standard for Telecommunications Pathways and Spaces | http://global.ihs.com |
| 4 | ANSI | ANSI/TIA/EIA-569-A-2-2000 | ADD 2 - Furniture Pathways and Spaces | http://global.ihs.com |
| 4 | ANSI | ANSI/TIA/EIA-569-A-3-2000 | ADD 3 - Access Floors | http://global.ihs.com |
| 4 | ANSI | ANSI/TIA/EIA-569-A-4-2000 | ADD 4 - Poke-Thru Fittings | http://global.ihs.com |
| 4 | ANSI | ANSI/TIA/EIA-569-A-6 | ADD 6 – Multi-Tenant Pathways and Spaces | http://global.ihs.com |

| | | | | |
|---|---|---|---|---|
| 4 | ANSI | ANSI/TIA/EIA-569-A-7-2001 | ADD 7 – Cable Trays and Wire Lines | http://global.ihs.com |
| 4 | ANSI | ANSI/TIA/EIA-607-A-2002 | Commercial Building Grounding and Bonding Requirements for Telecommunications | http://global.ihs.com |
| 4 | ANSI | ANSI/TIA/EIA-758-1-1999 | ADD 1 to TIA/EIA-758 | http://global.ihs.com |
| 4 | ANSI | ANSI/TIA/EIA-758-99 | Customer-owned Outside Plant Telecommunications Cabling Standard | http://global.ihs.com |
| 4 | ANSI | NFPA-70 | NEC 2002 | http://global.ihs.com |
| 4 | ANSI | T1.105-2001 | Synchronous Optical Network (SONET)-Basic Description including Multiplex Structure, Rates and Formats | http://webstore.ansi.org |
| 5 | ANSI | Y32.9-1972 | Graphic Symbols for Electrical Wiring and Layout Diagrams used in Architectural and Building Construction (DOD adopted) | http://webstore.ansi.org |
| 4 | TIA/EIA | TIA/EIA-422-B | Electrical Characteristics of Balanced Voltage Digital Interface Circuits | http://global.ihs.com |
| 4 | TIA/EIA | TIA/EIA-423-B | Electrical Characteristics of Unbalanced Voltage Digital Interface Circuits | http://global.ihs.com |
| 4 | TIA/EIA | TIA/EIA-472 | Generic Specifications for Fiber Optic Cables | http://global.ihs.com |
| 5 | IEEE | IEEE-315-1975 | Graphic Symbols for Electrical and Electronic Diagrams | http://webstore.ansi.org |
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| 5 | RUS | 1751F-640 | Design of Buried Plant - Physical Considerations | www.usda.gov/rus/telecom/publications/bulletins.htm |
| 5 | RUS | 1751F-641 | Construction of Buried Plant | www.usda.gov/rus/telecom/publications/bulletins.htm |

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| 5 | RUS | 1751F-643 | Underground Plant Design | www.usda.gov/rus/telecom/publications/bulletins.htm |
| 5 | RUS | 1751F-644 | Underground Plant Construction | www.usda.gov/rus/telecom/publications/bulletins.htm |
| 5 | RUS | 1751F-802 | Electrical Protection Grounding Fundamentals | www.usda.gov/rus/telecom/publications/bulletins.htm |
| 5 | RUS | 1753F-201 | RUS Standard for Acceptance Tests and Measurements of Telecommunications Plant | www.usda.gov/rus/telecom/publications/bulletins.htm |
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| 6 | Lucent | 628-200-200 | Underground Cable Placing, Rodding and Cleaning Ducts | http://www.lucentdocs.com |
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| 6 | Lucent | 628-200-208 | Underground Cable Placing | http://www.lucentdocs.com |
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| 6 | Lucent | 919-120-200 | Pole Lines Classification and Loading | http://www.lucentdocs.com |
| 6 | Lucent | 919-120-200 ADD | Pole Lines Classification and Loading | http://www.lucentdocs.com |
| 6 | Lucent | 919-120-600 | Pole Lines Design Considerations | http://www.lucentdocs.com |
| 6 | Lucent | 919-240-300 | Underground Conduit Manholes | http://www.lucentdocs.com |
| 6 | Lucent | 919-240-400 | Underground Conduit Materials Types and Fields of Use | http://www.lucentdocs.com |
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| 4* | ISO | BS EN 50174-2 | Information Technology – Cabling Installation - Part 2: Installation Planning and Practices Inside Buildings | http://global.ihs.com |

*For projects in Europe only.

ASTM=American Society for Testing and Materials; BICSI=Building Industry Consulting Services, International; BS=British Standards; CD-ROM=compact disk-read only memory; DIN=Deutsches Instutut für Normung e.V.; EN-Engineering Notice; GR=Generic Requirements; N/A=not applicable; IEEE=Institute of Electrical and Electronics Engineers; NFPA=National Fire Protection Association; TTC=Trenchless Technology Center; URL=Universal Resource Locator; VDE=Verband der Elektrotechnik Elektronik Informationstechnik

# GLOSSARY. ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AC | alternating current |
| ADD | Addendum |
| AND | area distribution node |
| AFCESA | Air Force Civil Engineer Support Agency |
| AFH | Army Family Housing |
| AIS | automation information system |
| AKM | Army Knowledge Management |
| ANSI | American National Standards Institute |
| ASTM | American Society for Testing and Materials |
| AT&L | Acquisition Technology and Logistics |
| AWG | American Wire Gauge |
| | |
| BAS | Building Automation Systems |
| BCS | Building Cabling System |
| BICSI | Building Industry Consulting Service International |
| BOQ | Bachelor officer's quarters |
| BS | British Standards |
| | |
| C&A | Certification and accreditation |
| C/C | center-to-center |
| C2 | command and control |
| Cat 3 | Category 3 |
| Cat 5 | Category 5 |
| Cat 5e | Category 5e |
| Cat 6 | Category 6 |
| CATV | cable television |
| CATV | community antenna television |
| CCB | Configuration Control Board |
| CCR | Criteria Change Request |
| CCTV | closed circuit television |
| CDN | converged distribution node |
| CD-ROM | compact disk-read only memory |
| $cm^3$ | cubic meter |
| CP | consolidation point |
| CTTA | Certified TEMPEST Technical Authority |
| | |
| D | Chromatic Dispersion Coefficient |
| DA | Department of the Army |
| DAA | Designated Accreditation Authority |
| dB | decibel |
| DB | direct buried |
| dBmV | decibel millivolts |
| DC | direct current |
| DCO | Dial Central Office |
| DDC | direct digital controller |
| DIN | Deutsche Industrie Normenasusschluss |
| DISA | Defense Information Systems Agency |
| DOD | Department of Defense |

| | |
|---|---|
| DOIM | Director of Information Management |
| DPW | Directorate of Public Works |
| DWDM | dense wave division multiplexing |
| | |
| EB | encased buried |
| EDP | Engineering Design Plan |
| EES | Earth Electrode Subsystem |
| EIA | Electronics Industry Association |
| EMT | Electrical metallic tubing |
| EN | Engineering Notice |
| ESM | enterprise systems management |
| EUB | end user building |
| | |
| FAX | facsimile |
| FDED | Fort Detrick Engineering Directorate |
| FO | fiber optic |
| FOC | fiber optic cable |
| FOCIS | Fiber Optic Connector Intermateability Standard |
| FOPP | fiber optic patch panel |
| FOUO | For Official Use Only |
| ft | foot/feet |
| | |
| GbE | Gigabit Ethernet |
| Gbps | gigabits per second |
| GHz | gigahertz |
| GIP | galvanized iron pipe |
| GPa | gigapascal |
| GR | generic requirement |
| GSA | General Services Administration |
| GSP | galvanized steel pipe |
| | |
| HCDS | hardened carrier distribution system |
| HDD | horizontal directional drilling |
| HDPE | High Density Polyethylene |
| HVAC | heating, ventilation, cooling |
| | |
| I3A | Installation Information Infrastructure Architecture |
| I3MP | Installation Information Infrastructure Modernization Program |
| IA. | information assurance |
| IATF | Information Assurance Technical Framework |
| IAW | in accordance with |
| ICEA | Insulated Cable Engineers Association |
| ID | identification |
| IEC | International Engineering Consortium |
| IEEE | Institute of Electrical and Electronics Engineers |
| IMA | information mission area |
| IMC | intermediate metal conduit |
| in | inches |
| IP | Internet Protocol |
| IS | information system |

| | |
|---|---|
| ISO | International Standards Organization |
| ISS | Information System Security |
| ISSE | Information Systems Security Engineering |
| IT | information technology, |
| ITU | International Telecommunication Union |
| ITU-T | International Telecommunication Union-Telecommunication Standardization Sector |
| km | kilometer |
| kPa | kilopascal |
| | |
| LAN | local area network |
| lb/in$^2$ | pounds per square inch |
| LOS | line-of-sight |
| LPAGBS | Lightning Protection, Power Quality Analysis, Grounding, Bonding, and Sheilding |
| LSA | line sharing adapter |
| | |
| M | cable sections |
| m | meter |
| MCN | main communications node |
| MDF | main distribution frame |
| MH | maintenance hole |
| MHz | megahertz |
| MIL-HDBK | Military Handbook |
| MIL-STD | Military Standard |
| mm | millimeter |
| MPa | Megapascal |
| MPD | Multiple Plastic Duct |
| MUTOA | multi-user telecommunication outlet assembly |
| | |
| N | newton |
| N/A | not applicable |
| NAVFAC | Naval Facilities Engineering Command |
| NEC | National Electrical Code |
| NEMA | National Electrical Manufacturers Association |
| NESC | National Electric Safety Code |
| NFPA | National Fire Protection Association |
| nm | nanometer |
| NMCI | Navy and Marine Corps Intranet |
| NSA | National Security Agency |
| NZDSF | non-zero dispersion-shifted fiber |
| | |
| OSHA | Occupational Safety and Health Administration |
| | |
| OSP | outside plant |
| OSPDPR | Outside Plant Design and Performance Requirements |
| OTDR | optical time domain reflectometer |

| | |
|---|---|
| PE | polyethylene |
| PET | protected entrance terminal |
| PMD | polarization mode dispersion |
| PoE | Power over Ethernet |
| ps | picosecond |
| PSI | pounds per square inch |
| PVC | polyvinyl chloride |
| | |
| QA | quality assurance |
| QC | quality control |
| | |
| RCDD | registered communications distribution designer |
| RMC | rigid metal conduit |
| RSC | rigid steel conduit |
| RSU | remote switching units |
| RUS | rural utilities service |
| | |
| SC | subscriber connector |
| SIDR-PR | Standard Specification for Polyethylene Plastic Pipe |
| SIPRNET | SECRET Internet Protocol Router Network |
| SONET | synchronous optical network |
| SOW | Statement of Work |
| ST | smart terminal |
| | |
| TC | telecommunications closet |
| TEF | Telecommunications Entrance Facility |
| TEMPEST | Telecommunications Electronics Material Protected from Emanating Spurious Transmissions |
| TG | Technical Guide, viii |
| TIA | Telecommunications Industry Association |
| TIC | Technology Integration Center |
| TR | telecommunications room |
| TR | Technical Report |
| TSB | Technical Service Bulletin |
| TTC | Trenchless Technology Center |
| | |
| UFC | Unified Facilities Criteria |
| UFGS | Unified Facilities Guide Specification |
| UL | Underwriters Laboratory |
| UPS | uninterruptible power supply |
| UPSR | unidirectional path switched ring |
| URL | Universal Resource Locator |
| USACOE | U.S. Army Corps of Engineers |
| USAISEC | U.S. Army Information Systems Engineering Command |
| UTP | unshielded twisted pair |

| | |
|---|---|
| VDE | Verband der Elektrotechnik Elektronik Informationstechnik |
| VoIP | Voice over Internet Protocol |
| | |
| WAP | Wireless access point |
| WLAN | wireless local area network |
| WWW | World Wide Web |